SCIENTIFIC AMERICAN

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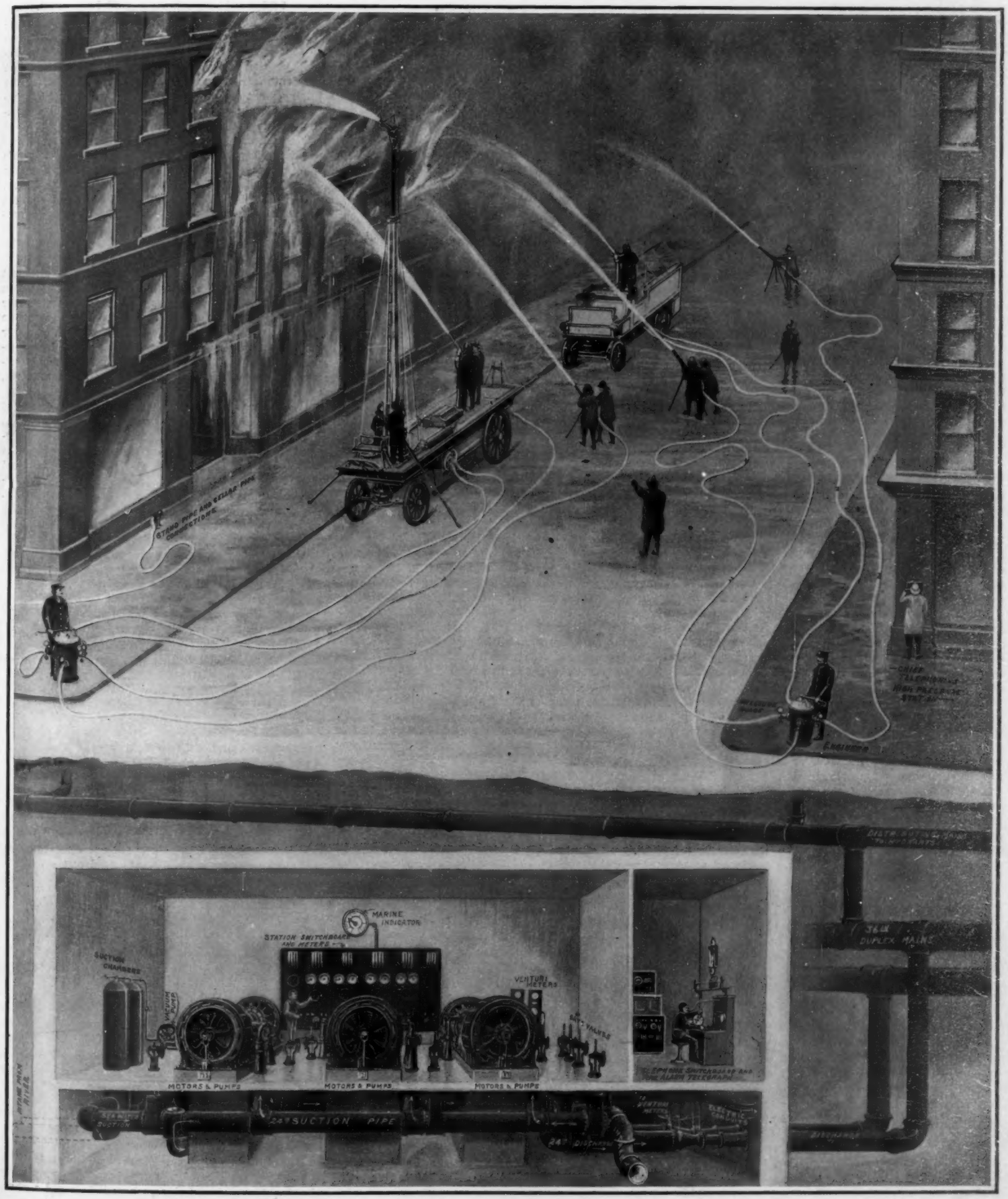
A POPULAR ILLUSTRATED WEEKLY OF THE WORLD'S PROGRESS

Vol. CII.—No. 23. ESTABLISHED 1845.] NEW YORK, JUNE 4, 1910. [10 CENTS A COPY. $3.00 A YEAR.



Notice of a fire comes to the operator at telephone (see view of pumping station), who instructs engine room crew by means of marine telegraph. The engineer at switchboard starts electric pumps, which draw water from the water mains or the river, and deliver it through mains to the district in which fire rages. The chief at the fire is in touch with station operator through special telephone wire.

FIRE FIGHTING WITHOUT FIRE ENGINES.—**[See page 458.]**

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ESTABLISHED 1845

MUNN & CO., Inc., - Editors and Proprietors

Published Weekly at
No. 361 Broadway, New York

CHARLES ALLEN MUNN, *President*
361 Broadway, New York.
FREDERICK CONVERSE BEACH, *Sec'y and Treas.*
361 Broadway, New York.

TERMS TO SUBSCRIBERS.

Subscription one year..... $3.00
Postage prepaid in United States and possessions
Mexico, Cuba and Panama.
Postage to Foreign countries..... $1.50 per year extra.
Canadian postage..... .75 per year extra.

THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (established 1845)..... $3.00 a year
Scientific American Supplement (established 1876)..... 5.00 "
American Homes and Gardens..... 3.00 "

The combined subscription rates and rates to foreign countries, including Canada, will be furnished upon application.
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., Inc., 361 Broadway, New York.

NEW YORK, SATURDAY, JUNE 4th, 1910.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

WHAT WILL THE RAISING OF THE "MAINE" DISCLOSE?

THE action of Congress in passing a bill making a preliminary appropriation for the work of raising the wreck of the "Maine" is, for several reasons, highly commendable. Chief among these is the opportunity which will be afforded to give decent burial in the national cemetery at Arlington to the bodies of the unfortunate men, who were carried down in the wreck of the ship, and have remained entombed for the past twelve years. Look at it whatever way we will, the fact that no effort has been made to recover these bodies carries with it a certain uncomfortable aspect of neglect; and the nation owes it to the memory of the dead; to the sensibilities of their surviving relatives; and lastly, to its own dignity and self-respect, to recover what may be left of the mortal part of these brave seamen, and give them decent interment with proper military honors.

Second only in importance to the above considerations are those which affect the sensibilities, and particularly the sense of honor, of a European power with whom we are at present, and hope ever to be, on terms of friendly understanding; for it is a fact that the Spanish government felt very keenly the implication that the destruction of the "Maine" was brought about by Spanish agency—an implication which, though not expressed, yet necessarily followed from the finding of our Naval Board of Inquiry, which concluded that the "Maine" was destroyed not from within, but from without. "In the opinion of the Court," says the report, "this effect could have been produced only by the explosion of a mine situated under the bottom of the ship at about frame 18, and somewhat on the port side of the ship."

Now, although our Navy Department did not then, and does not now, believe that the Spanish officials were in any way concerned in the disaster, attributing the explosion to the hatred of fanatics, it is doubtful if this opinion was shared, or is even yet held, by the majority of people in the United States Therefore the raising of the "Maine" will be well worth all the trouble and cost it will entail, if the thorough physical examination of the wreck which can then be made, brings to light clear evidence that the explosion was due to internal causes, that is to say, to the spontaneous and therefore accidental combustion of the explosives contained in the forward magazines. This latter was the explanation offered by the Spanish Naval Board which examined the wreck at the time of the disaster; and it is significant that it received credence, not only among naval experts abroad, and especially those of England, whose attitude was markedly friendly at the time, but also among not a small percentage of the officers of our own navy.

It would be a "consummation devoutly to be wished" if the raising of the wreck should afford ample evidence, or even a strong presumption, that the "Maine" was wrecked by spontaneous explosion in the magazines. Such a conclusion would cast no discredit whatever upon the officers and men who had charge of the "Maine" on that fatal night; for it is well understood, and has been proved by accidents such as that which occurred on the French battleship "Jena," that under the conditions in which powder was stored at that period and for some years later, it was possible for spontaneous combustion to have taken place in spite of that strict observance of regulations, which the evidence before the Board showed to have been followed on the "Maine."

Now, if this occurred, the tearing asunder of the protective deck and the blowing out of the sides of the vessel, accompanied by the instant flooding of the portion of the ship forward of the explosion, would have caused the weight of the ram bow, the anchors and anchor chains, to bend the forward portion downward until the ram was hanging vertically below the ship, held thereto only by the floor and keel plates. Then, as the main portion of the ship filled and sank, the bottom of the ship would naturally be folded down vertically against itself, leaving the keel and the double bottom in that peculiar, inverted-V position, which gives it the appearance of having been blown up by some powerful force acting from below.

When the cofferdam has been built entirely around the wreck and the water pumped out, it will be possible, in all probability, by a careful examination of the wrecked structure, to determine how far this theory is correct. If it be proved, there will be cause for general congratulation. With that awful tragedy transferred to the category of unpreventable accidents, a proud nation with whom we are in friendly relationship will be vindicated from a charge which even today is a source of resentment, that is none the less real because it is unexpressed.

REVIVAL OF THE ROTARY ENGINE.

IN the introductory article of a series dealing with the rotary engine, which was published in the year 1897 in the SUPPLEMENT (Vol. xliii., Nos. 1109, 1110, 1111), we said: "The constant failure that has attended the efforts to produce a successful rotary engine, and the fact that the direct-acting, crank-and-rod, reciprocating engine has retained full possession of the field, have led many people to suppose that the rotary engine inventor is as visionary a dreamer as the would-be inventor of perpetual motion. As a matter of fact, however, many of the objects aimed at in the first device are as legitimate and useful as those of the latter are absurd and impossible. While the supposed advantages of a rotary engine, as outlined below, have proved very attractive to the inventor, the results of careful comparative tests have shown that, except in the case of rotary impact engines or steam turbines, the rotary engine does not compare in efficiency with the ordinary reciprocating type. . . . Now it would certainly seem that with such theoretical and practical mechanical features in its favor, the rotary engine would prove a formidable rival to the standard type. But this it has never done, and for the very practical reason that, owing to its peculiarities of construction, it is difficult to secure an economical regulation of the steam supply, and it is impossible to keep the joints steam tight and prevent irregular wear of the parts. The wear of the piston is always greatest at the circumference of the cylinder, decreasing toward the center, and this structural defect has thus far baffled the efforts of the mechanic. The packing devices that bear against the circumference of the cylinder, like the piston rings of a vertical direct-acting engine, show an equal wear throughout; but no amount of ingenuity has yet succeeded in compensating the variable wear of the side packing. There is a further difficulty in the fact that in rotary engines that have only one admission port, the steam pressure produces a rapid side wear on the shaft, and renders it difficult to keep the stuffing box steam-tight. Another difficulty is experienced with the valve gear, which in the great majority of rotary engines is of the reciprocating type. Reciprocations which would involve no serious wear at a moderate speed become serious at the enormous speed of the rotary engine, and produce rapid wear of the parts."

Such was the situation in the rotary engine field about a dozen years ago. The difficulties were of a purely mechanical kind; for the theoretical advantages of the type were highly attractive and never disputed. We remember asking the late George M. Hopkins, a mechanical engineer of exceptional constructive ability, who had devoted a large amount of effort to the problem, what he thought were the prospects for the production of a successful motor of this type. He expressed the opinion that the large steam leakage, due to the impossibility of making successful frictional joints, coupled with the heavy frictional losses, to say nothing of the rapid wearing out of the reciprocating valve movements, had convinced him that no successful rotary could be built.

As the matter then stood, it was evident that a rotary engine, to be successful, must be absolutely rotary in all its parts and free from any reciprocating movements whatsoever; that the rubbing surfaces must be reduced to a minimum, if not altogether eliminated; that steam leakage must be greatly reduced; and that some mechanical means must be found for eliminating the uneven wear on the main bearings due to the eccentric application of the load. In the intervening years, in spite of apparently insuperable difficulties, inventors have struggled with the problem with that indomitable perseverance which is so frequently characteristic of their work; with the result that at last a rotary engine of twenty horse-power has been developed, which has shown its ability to perform steady shop duty, day in and day out, for a period of six months, without showing any signs of deterioration. Reference is made here to the exceedingly interesting engine, recently tested at Stevens Institute, which forms the subject of an illustrated article on another page. It will be recognized, on a study of the drawings and description, that success has been achieved by meeting those very conditions of a mechanical nature, which the experimental work of the past hundred years had shown to be essential in a rotary engine. The tests at Stevens Institute and at the contractors' plant speak for themselves. It remains for the future to determine how far the rotary will succeed in the new field of high-pressure, superheated steam, for which, theoretically, it would seem to be admirably adapted.

THE GOVERNMENT AND THE INVENTOR.

THE Committee on Patents has under consideration a bill introduced by Mr. Currier, the purpose of which is to enlarge the jurisdiction of the Court of Claims so that the Court may entertain suits against the United States for the infringement or unauthorized use of a patented invention in certain cases, and award reasonable compensation to the patentee.

The measure is necessary, when it is considered that under the English common law, which prevails in this country as well as in England, a sovereign power cannot be sued without its own consent. The United States has established a regular tribunal, and charged it with the duty of adjusting claims against the government, but the scope of its duties does not include the adjudication of an inventor's rights when his invention has been appropriated by his government.

When the government issues a patent, it does not grant a favor to the inventor, but it "secures him a right," in the language of the Court in U. S. vs. Palmer (128 U. S. 271), and this securing of a right by no possible implication carries with it the opposite power of destroying the right in whole or in part by appropriating it to the purposes of government without complying with that other condition of the Constitution, the making of "just compensation."

For all that, many inventors have spent years of their lives and practically bankrupted themselves in developing inventions primarily of use to the government, only to find in the end that their property has been practically confiscated, that they have no legal means of redress, and that the governmental departments will not recognize the decisions of the courts. No doubt the government has the right to appropriate an invention necessary for the preservation of the national defense, yet appropriation having been made, it would seem that some compensation should be paid.

Despite the decisions of the Supreme Court, despite the fifth amendment to the Constitution, which provides that no private property shall be taken for public use without compensation, the government again and again seizes private property, in the form of patent rights, without compensation. The Court of Claims now has no jurisdiction to award compensation for the governmental use of a patent, except when such use is under a contract. To extend the jurisdiction of the Court, so that it may entertain suits and award compensation to the owners of patents in cases where the use of the invention by the United States government is unauthorized, is the purpose of Mr. Currier's bill.

A similar measure was introduced by Congressman Dalzell in the closing days of the last Congress. The measure passed both the House and the Senate, but it was not signed by the President. Mr. Currier's bill is practically the same as Mr. Dalzell's, with the exception that certain patents taken out by government officers or employees, which are good against all the world, are not good against the government. This is as it should be; for when a government officer is assigned to the task of devising an implement, and the government bears the expense incidental to the invention, and the officer continues to draw his salary in the meantime, it is evident that the government is the implied owner or at least licensee of the invention.

The experimental researches into the effect of electricity upon fog commenced by Sir Oliver Lodge in Liverpool, and continued by him in Birmingham, have been temporarily suspended. The reason for this, the Electrical Engineer states, is not any modification of Sir Oliver's views on the subject, or any cessation of his interest. It is simply that the spot selected for the experiments in the neighborhood of the old university buildings in Edmund Street has failed to furnish the *corpus vile* in the shape of fogs to disperse. There is a proposal to conduct a similar experiment under Sir Oliver Lodge's direction and on a more extensive scale in London, somewhere in the neighborhood of Hungerford Bridge, where it is hoped a choice assortment of fogs may be more often available. A sum of about $5,000, however, is required in order to enable this installation to be made, and at present it is not clear how the funds are to be obtained.

ENGINEERING.

It is claimed by the contractors that a new record for American shaft sinking has been accomplished on the Moodna siphon of the New York city Catskill aqueduct, where a shaft 16 feet 8 inches in diameter was sunk 177 feet in thirty-one days. The work was done in hard Hudson River shale.

In a recent government test over the measured mile course off Rockland, the new battleship "Michigan" covered the fastest mile out of twenty successive runs at a speed of 19.54 knots, which exceeds by more than half a knot the fastest mile made at the builders' acceptance standardization trial.

The first of three concrete barges which will be used in the hydraulic operation at the Panama Canal was recently launched. It draws when complete with dredging pump, motor, and equipment, three feet nine inches. One-quarter-inch No. 12 wire mesh has been used in the wall construction. The behavior of these barges will be watched with great interest.

The Interstate Commerce Commission has recently ruled that, hereafter, on several railways in the Northwest, the upper berths in Pullman sleeping cars are to cost less than the lower berths. The Commission states that, in the past eleven years, the Pullman company has doubled its capitalization and dividends without the investment of any new capital.

The latest report of work on the New York State barge canal shows that this great undertaking is being pushed through with dispatch. At the present time, 333.6 miles of the total work is under contract; additional plans have been completed for 48.2 miles; and the plans for another 26.4 miles are over seventy-five per cent completed, leaving 6.4 miles, the plans of which are in progress.

With a view to determining whether or not the new type of shells will be deflected when striking at an angle, or whether they will bite into the plate, several of the new soft-nosed naval shells were fired from a 12-inch gun at the old ram "Katahdin," which was stricken from the navy list, and consigned to the scrap heap in July of last year. The hull was protected by the latest 12-inch armor plate, in sections arranged on the vessel at various angles.

An eyebar made by the American Vanadium Company was recently tested to destruction by the American Bridge Company. The test bars, which were of vanadium-nickel steel, measured 14 inches by 2 inches by 35 feet. The results showed an elastic limit of 80,840 pounds, and a tensile strength of 99,890 pounds per square inch, with an elongation of 32.5 per cent in 12 inches, and a reduction in area at fracture of 52.3 per cent. Part of the bar was bent cold under a 14,000-ton press, and flattened upon itself without sign of fracture. Should the matter of price not prove an obstacle, this will be an ideal material for the eyebars of long-span bridges.

Efficiency tests are conducted by officials of the Pennsylvania Railroad, who, at unusual times and places, set signals of caution or danger, display fusees, or place torpedoes on the track, with a view to keeping all employees constantly on the alert for signals. During the tests for 1909, the following records were made by the men: Block signal rules, 47,384, of which 99.6 per cent showed perfect observance on the part of the employees; 45,887 tests of rules governing flagmen, use of fusees, torpedoes, and other signals, 99.6 per cent perfect. Altogether, some 300,000 efficiency tests showed a practically perfect record for the employees.

Acting in accordance with the Spooner act of June 28th, 1902, which states that "the President shall cause to be constructed such safe and commodious harbors at the termini of the Panama Canal, and make such provisions for their defense, as may be necessary for the safety and protection of said canals and harbors," President Taft has asked for an appropriation of $4,000,000 for the commencement of suitable fortifications. He indorses the report of a special board of officers of the army and navy, which provides, we understand, for an adequate defense by batteries mounting the new 14-inch gun. The total cost of the completed fortifications will be about $15,000,000.

A most commendable movement in the anthracite region of northeastern Pennsylvania is the introduction of mine schools. In former days, the English-speaking and Teutonic races, skilled in mining, predominated in this district; but to-day work is done by a class of Europeans whose traditions and experience have nothing to do with mines. Several of the mining companies have established schools for the benefit of these employees, one of the first of which was that established by the Philadelphia & Reading Coal and Iron Company. Here, in attendance, are found the apprentices and journeymen employed in the shops, and the mine workers. The course, which includes mathematics and drawing, has special reference to the particular class of work in which the employees are engaged.

ELECTRICITY.

In his presidential address before the American Electro-Chemical Society at Pittsburg, Dr. Leo H. Baekeland stated that "the last hundred years, under the influence of the modern engineer and scientist, have done more for the betterment of the race than all the art, all the civilizing efforts, all the so-called literature of past ages, for which some respectable people want us to have such an exaggerated reverence."

The thirty-third convention of the National Electric Light Association, which met at St. Louis last week, reported a very prosperous year, in which 2,200 members were added, bringing the total membership up to 5,370. The association began in 1885, with a membership of only 71. There are 820 operating companies represented in the association, and these constitute 90 per cent of the capitalization of the electric light industry in this country.

A new form of mercury-rod interrupter has been developed, with the object of producing a sharper break. It consists in covering the mercury with a quenching liquid. As the rod is withdrawn from the mercury, a bubble of vapor from the quenching liquid forms on the end of the rod and tends to press the mercury level suddenly downward at the break, thus effecting a more perfect current interruption, even though the rod may rise comparatively slowly from the mercury.

The New York Legislature has passed the bill which places telegraph and telephone companies of the State under the supervision of the Public Service Commission for the second district. The bill empowers the Commission to investigate and regulate the rates and service. The companies are required to file annual reports, and the Commission may veto any privileges under the franchises of the companies which have not as yet been exercised. Reduced rates, passes, or franks for the transmission of messages are prohibited.

A novel ventilating system has recently been developed, which consists of a small electric fan connected to the window sill in such manner that it may be operated either to draw in air from the outside or to exhaust the air from a room. It is suggested that the value of this will be appreciated in a kitchen on ironing day, or when any baking is being done, as it prevents the heat from spreading through the entire house, besides making the kitchen itself more comfortable to work in.

In order to determine the heat generated by concrete when hardening, six thermometers of special construction are to be imbedded in the concrete walls of the Gatun locks of the Panama Canal. Each thermometer consists of an iron cup in which is a resistance coil. This is connected by a pair of lead-sheathed copper wires to an indicating instrument and a small storage battery. Variations in the temperature of the coil produce variations in the electrical resistance, and this is indicated on the instrument, which is calibrated to show degrees of temperature. The instrument keeps a continuous record, which should prove of considerable scientific interest and importance.

It is a difficult matter to measure very high tensions of electrostatic or Wimshurst machines, owing to the glow discharge which is apt to occur above 40,000 volts. A new method has been adopted by Prof. C. F. Guye and Mr. A. Tscherniavski, which was recently submitted to the French Academy of Sciences. This consists in inclosing the spark gap and the electrometer in a substantial box, in which compressed gas is introduced. According to the Paschen law, the disruptive potential is approximately proportional to the gas pressure. Thus, with a given potential difference, the electrodes of the spark gap can be approached to each other in proportion to the increase of gas pressure, and by this shorter gap the electrostatic effects are reinforced, insuring more accurate readings. This method has been employed in measuring the tension of a Wimshurst machine, which showed a voltage of 80,000 with a pressure of from 4 to 9 atmospheres in the inclosing box.

Last November there was a series of heavy snowstorms in Germany, which did considerable damage to overhead telephone and telegraph lines. As a result, a careful investigation was made of the question of putting such lines underground, and it was found that by using the Pupin system, underground cables could be used to good advantage on lines of less than 600 miles in length, with wires not more than three millimeters (0.118 inch) in diameter. The advantages of the underground system were found to be as follows: That there would be no interruptions due to external causes, that there would be no danger of cross talk, that the efficiency of the line would always be constant, that there would be no interruptions or expense for repairs, due to external causes, and that while laying the cables extra wires could be provided, which would permit of further expansion to meet future demands. It was also shown that telegraph and telephone lines could be laid in the same cables without danger of inter-disturbance.

SCIENCE.

Mr. Charles H. Peck, botanist of the State of New York, in his annual report states that the known species of edible mushrooms in New York amounts to 200. Five new kinds of edible mushrooms were discovered in the last year.

Dr. Charles Forbes, of the Department of Physics in Columbia University, has installed in Barnard College the first permanent apparatus for the installation of the Foucault experiment, to show the motion of the earth. Dr. Forbes set up a temporary apparatus for the experiment in St. Paul's Chapel of Columbia University some two years ago, which was described in these columns.

Dr. William Phipps Blake, a member of the first class ever graduated from the Sheffield Scientific School of Yale, died recently at Berkeley, California, shortly after he had received the degree of LL.D. from the University of California. Prof. Blake was 84 years old. When he graduated from Yale in 1853, he became the geologist and mineralogist for the United States Pacific Railroad expedition. His numerous activities included the editing of the Mining Magazine, geological work for the Japanese government, the exploration of a section of Alaska, the teaching of mineralogy and geology in the College of California, a geological examination of Santo Domingo, and the teaching of geology in the University of Arizona.

The satisfactory examination of the absorption spectra of glass of various sorts requires, in addition to the thermopile, a spectrometer with glass or quartz lenses and prisms, and the exact determination of the wave length of the limit of transparency requires the use of a slit with very sharp edges, a camera with an excellent lens, and a source of light, the spectrum of which contains many sharply-defined lines and extends far into the ultra-violet. The spectra hitherto employed for this purpose, including the spark spectrum of an alloy of cadmium, zinc, and lead, the spectrum of mercury, obtained by means of the vacuum tube or the electric arc, the spectrum of the carbon arc, and even that of the Heraeus amalgam lamp (mercury, lead, bismuth, zinc, and cadmium), contain too few lines to give satisfactory results. Zickendraht has recently employed the arc spectrum of iron, which, because of its extraordinarily large number of lines of accurately known wave length, appears especially well adapted for the study of absorption in glass. A Zeiss spectrometer with quartz lenses and prisms was used. The results, which are published in tabular form, are too complex to be briefly described.

Prof. Haber claims to have solved the problem of the direct synthesis of ammonia from its elements, nitrogen and hydrogen. The process has been purchased by the well-known German establishment, the Badische Anilin und Soda-Fabrik. If the process is as practical and economical as its inventor claims, its introduction will quickly cause a revolution in a comparatively new but already important branch of industry, the manufacture of artificial nitrates. In several countries possessed of abundant water power, large nitrate factories, in which oxygen and nitrogen are combined directly by means of the electric arc, are in operation. Prof. Haber gives a few details concerning his process, but states that the combination of hydrogen and nitrogen is effected at a temperature of about 1,000 deg. F. and a pressure of 200 atmospheres. In a recent lecture he exhibited an experimental apparatus which produced three ounces of liquid ammonia per hour. The presence of a catalyzer is required to accelerate the combination. For this purpose, Prof. Haber employs uranium, but the rarity of this element appears incompatible with its employment on a commercial scale.

The adulteration of food in France is said to result in a profit of one hundred million dollars per year. Bread, which may be called the national food of France, has long been adulterated largely with talc, a substance which is not only indigestible, but is exceedingly irritating to the gastro-intestinal mucous membrane because of the sharp crystal fragments which it contains. Flour is often mixed with alum or with potassium carbonate to increase the amount of water absorbed, with zinc sulphate to keep the bread fresh, with copper sulphate and ammonium carbonate, to diminish the quantity of yeast required and to improve the appearance of bread made with spoiled flour. Denatured alcohol, costing one-eighth the price of pure alcohol, is used for the manufacture of the liqueurs and *apéritifs*, which are so largely consumed in France. Alcohol, denatured by the addition of methyl alcohol, is mixed with an equal volume of water and exposed for a few days to the sun, air and rain, which have the effect of precipitating the methyl alcohol so completely that its flavor remains barely perceptible. The mixture is then brought to the desired alcoholic strength by the addition of strong spirits, flavored to suit the taste of the consumer and sharpened by the addition of a pint of nitric acid to each barrel.

A COMMERCIAL ROTARY ENGINE

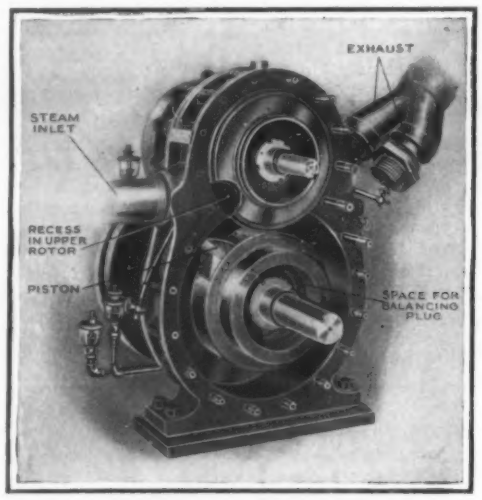
PRACTICAL SOLUTION OF AN AGE-LONG PROBLEM

Elsewhere in this issue we have discussed editorially the problem of the rotary engine, and set down the mechanical difficulties which must be mastered before a successful engine of this type can be produced. Reference was made to the fact that a recent rotary engine has undergone a successful laboratory test at the Stevens Institute, and a successful commercial test of six months' duration at the plant of a leading contractor in this city. This engine, which was designed and built by Mr. Gerardus P. Herrick, of 74 Broadway, this city, forms the subject of the accompanying illustrations. The principal distinguishing features—those which contribute more than any others to its success—are, first, the fact that reciprocating movements are entirely eliminated, all of the movements being rotary; and secondly, that the main shaft of the engine runs upon a film of steam, whereby the destructive thrust, transverse to the axle, is completely counterbalanced.

Mechanical Features.—The engine consists of two rotors or drums of equal diameter, placed one above the other, and running with the barest clearance between their peripheries. By means of external gears, they are caused to rotate in opposite directions at the same speed. The upper drum rotates within a closed cylindrical casing, between the walls of which and itself there is a bare micrometer clearance. The lower, or what we might call the power drum, rotates within a casing of larger diameter than itself, and it is provided with a rectangular piston which fills the annular space between the external periphery of the drum and the internal periphery of the casing. This drum and its attached piston also rotate within their casing with only a micrometer clearance between the adjacent surfaces. The peripheries of the upper and lower casings intersect each other sufficiently to allow the upper drum to project within the lower casing until it rotates with only the slightest clearance between itself and the power drum.

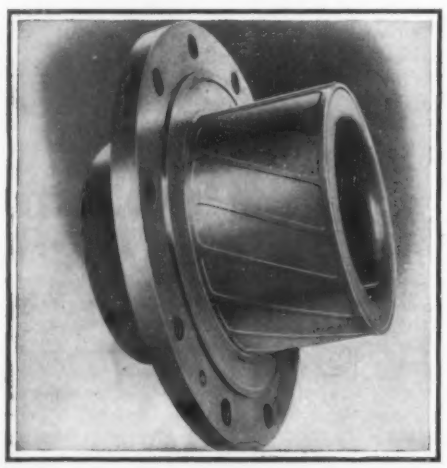
Valve Mechanism.—Sunk in the upper drum is a transverse, semicircular recess, which serves at once as a pocket to admit the piston of the lower drum as the two drums roll together, and also as an admission valve for the live steam, the proper registering of the piston with this pocket being assured by the fact that the two drums are geared together. Steam is admitted on one side of the engine and exhausted on the other. The successive admission, expansion, and exhaustion of the steam are simple and easy to understand. As the piston (which, viewed from the side of the engine shown in our drawing, moves opposite to the hands of the clock) clears the pocket in the upper drum, the latter moves forward until its leading edge clears the lower edge of the steam inlet, when live steam is admitted to the annular space back of the piston and continues to flow therein until the after edge of the pocket has swung round clear of the steam cylinder. This point of cut-off is the position chosen for the accompanying illustration. During the rest of the stroke, the steam works expansively, until the after face of the piston clears the forward edge of the exhaust ports, which are shown in dotted lines at the end of the circular path swept through by the piston.

Steam Counterbalance.—The most original and valuable feature of this engine is the ingenious method by which the heavy load on the main shaft, due to the radial steam pressure in the cylinder, is exactly counterbalanced by a steam pressure acting in the opposite direction, the rotor being balanced in its own steam. This is accomplished by means of what are known as balancing plugs, which are inserted in steam-balancing chambers. There are two of these plugs, one on each side of the engine. They are made of sufficient length and diameter to provide an area which, at any part of the stroke, is exactly equal to the area of the surface of the drum which is under the pressure of the live steam. For a little over half their periphery, and on the side immediately opposed to that portion of the annular cylinder space upon which the heaviest steam pressure is developed, the balance plugs are provided with a series of recessed steam pockets, and steam is admitted to these pockets successively by a series of holes drilled through the drum. Consequently, the thrust of the steam toward the shaft of the rotor is, for all positions, constantly balanced by an equal thrust of the steam away from the shaft. Perfect balance is secured, the rotor practically running upon a fine film of live steam. The advantages of this ingenious arrangement are that, not only are costly friction and destructive, uneven wear of the shaft journals prevented, but it is possible to mount the rotor on finely adjusted ball bearings, whose duty is simply to keep the rotor in true axial alignment.



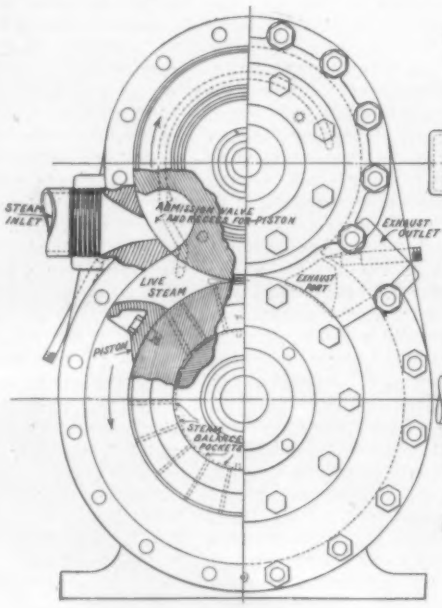
The piston is shown at cut-off. Note small holes back of piston to admit steam to balancing-chambers.

Rotary engine with side plates removed.

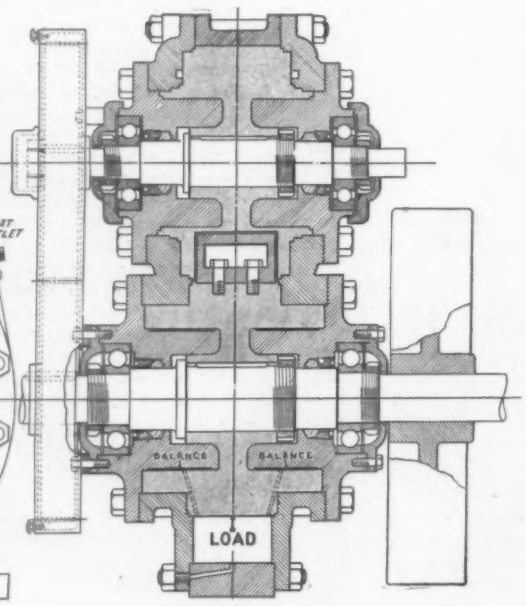


By this device the rotor rides on a film of steam and the load is taken off the main bearings.

The balancing plug.



This view shows the valve mechanism at point of cut-off.



Irregular sectional view, showing the piston within the valve pocket.

A PRACTICAL COMMERCIAL ROTARY ENGINE.

Absence of Rubbing Surfaces.—Another feature which has contributed largely to making this rotary engine practical, is the abolition of packing devices between the adjacent moving surfaces. Knowing the impossibility of keeping the usual packing devices steam-tight, Mr. Herrick decided to abolish them, and reduce leakage by machining the parts so carefully that they could be adjusted to run with the smallest micrometer clearances. That this has been accomplished successfully is proved by the fact that in the tests at Stevens Institute, this engine developed 20.5 brake horse-power on a steam consumption of 50.7 pounds per brake horse-power per hour; which compares favorably with the steam consumption of the average reciprocating engine of similar capacity. It will be realized that by getting rid of packing devices and introducing a system of steam balancing, Mr. Herrick has not only prolonged the life of the rotary engine, but he has greatly increased its output by getting rid of that accumulated friction which, in earlier forms of the rotary, was sufficient to cut down the economy to a point which rendered them commercially unserviceable.

Laboratory Tests.—In his report of the laboratory tests at Stevens Institute, Prof. Pryor states that he obtained the following results: With a steam pressure of 145 pounds and 1,006 revolutions per minute, 20.48 brake horse-power was obtained with saturated steam, on a consumption of 50.7 pounds of water per brake horse-power per hour. With a steam pressure of 135.5 pounds and 55 deg. of superheat, the engine at 1,008 revolutions per minute developed 20.40 brake horse-power on a consumption of 44.4 pounds of water per hour. In commenting upon these tests, Prof. Pryor says of the engine: "Its steadiness of operation, its lack of vibration, and its output per cubic foot of space occupied, should be particularly commended."

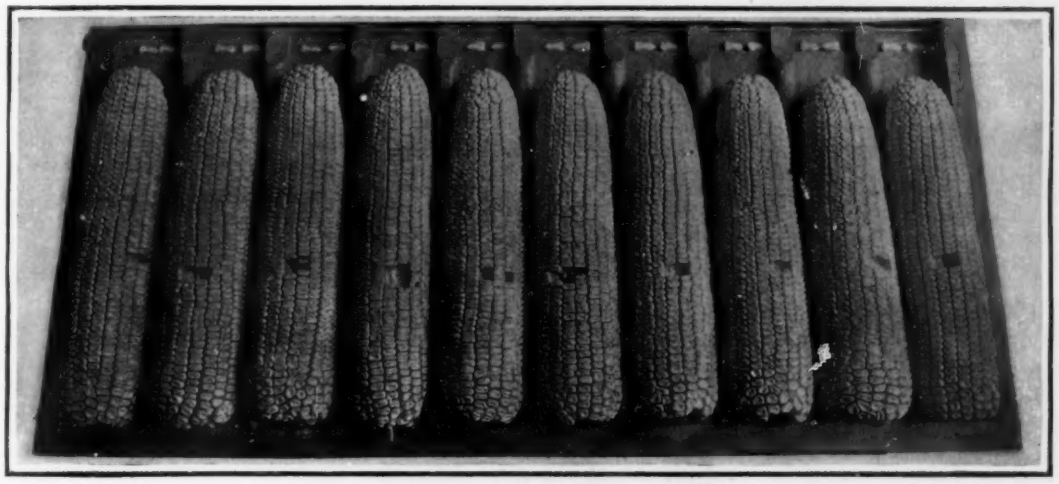
Commercial Test.—To test its commercial value over a long period of time, the engine was coupled to a dynamo at the Degnon Contracting Company's plant in this city, and from August 14th to December 21st, 1909, it served to produce the current for lighting the plant day and night. It was run for 1,685 hours, or the equivalent of more than six full working months. At the end of this time, it was again tested at the Stevens Institute; when, under similar conditions of revolution and steam pressure to those which obtained at the first test, the steam consumption was found to be 52.6 pounds, the slight increase being attributed by Prof. Pryor to the fact that new ball bearings had been put in without sufficiently careful adjustment, and some rubbing of adjacent surfaces had occurred.

Future Field of the Rotary.—Apart from the field of usefulness open for the rotary because of its compactness, simplicity, perfect balance, and moderate steam consumption, there is a far wider and more important field presented in connection with the steam turbine. We have frequently in this journal drawn attention to the fact that the steam turbine is most efficient in the lower ranges of the expansion of the steam; and that in the higher ranges, because of leakage over the ends of the blades, it is not so economical; and that at low speeds it is decidedly uneconomical. Furthermore, the turbine cannot economically make use of high-pressure steam or of superheated steam, and consequently it is shut out from all those well-known economies which the use of high-pressure and large superheat secure. Now the rotary engine is ideally adapted for both high pressure and superheat, and this fact is recognized by L. D. Lovekin, the chief engineer of the New York Shipbuilding Company, in the following statement: "A practical rotary engine working in conjunction with any of the well-known steam turbines, such as

(*Concluded on page 468.*)

THE COSTLIEST EAR OF CORN IN THE WORLD

BY FRANK C. PERKINS



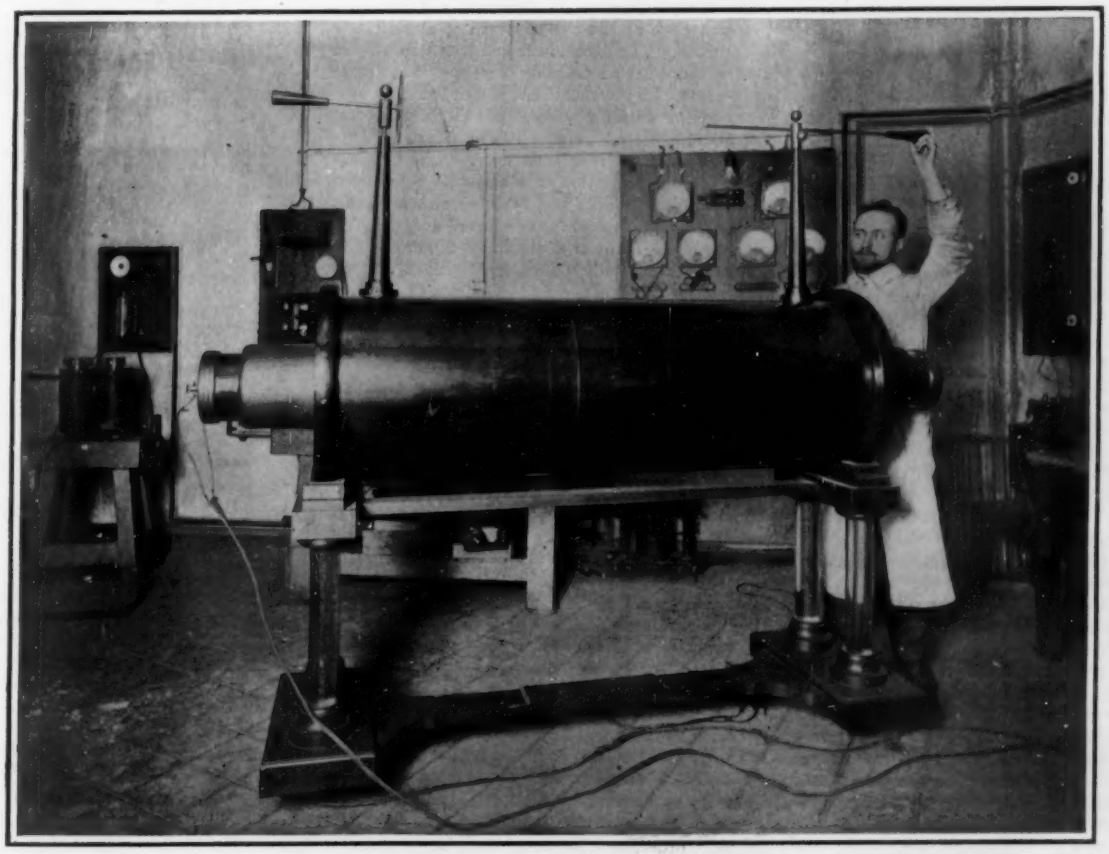
THE COSTLIEST EAR OF CORN IN THE WORLD.

In the accompanying illustration we present ten champion ears of corn, which were sold at the rate of $2,345 per bushel, or $335 for the ten ears, one of the highest prices, if not the highest price, paid for that number of ears of corn. The champion single ear of corn was sold at the Omaha National Corn Show for $85, or at the rate of $5,950 per bushel, which is said to be the highest price ever paid for a single ear of corn. The champion ten ears of corn shown in the illustration average 10½ inches in length and 7¾ in circumference, each ear carrying 20 rows of kernels, the depth of the kernels being ⅜ of an inch, and the average weight of each ear was 20 ounces. Prize agricultural products such as these may not be adapted to all localities, for which reason one must not be misled by the awarding of a prize. In some localities the prize corn might not be so profitable, or at least not so profitable as other varieties. Furthermore, the price at which ears of corn are sold may be a fictitious or a forced one. A farmer may take a prize at a fair. When the corn is put up at auction, the farmer, having received a large amount as premium for the champion corn, can afford to bid it in at a higher price than his competitors. The high price paid would therefore be for advertising purposes. Lastly, it must be considered that from a large field of corn some large specimens may be selected. This does not prove that the selected specimens are the best, but merely the largest.

A GIANT RUHMKORFF COIL

BY JACQUES BOYER

The first induction coil was made by Masson and Bréguet in 1842, but it was not until 1851 that Ruhmkorff gave the instrument its definite form, which has not sensibly varied since that time, although it has been improved and modified for various applications. Ruhmkorff increased the number of turns of wire of the secondary circuit, for which he employed a very fine and very long wire. Perfect insulation was obtained by saturating the coil with gum lac and the intensity of the magnetic force was increased by inserting a core of parallel iron wires inside the concentric coils. These wires are magnetized by the primary current and the magnetic flux produces currents in the secondary circuit.



A GIANT RUHMKORFF COIL.

The principal improvements which have been made in Ruhmkorff's original coil are the following: In the first place, Fizeau increased the power of the instrument by connecting the ends of the primary coil with the electrodes of a condenser, composed of sheets of tinfoil, insulated by silk and placed in the base of the instrument. The extra current which is formed on breaking the primary circuit flows into this condenser instead of forming a spark. The primary current is thus arrested more suddenly and the electromotive force of the induced current is correspondingly increased. For the construction of large induction coils, Poggendorff devised the plan of dividing the secondary circuit into a series of coils of short lengths, placed end to end, instead of winding the wire in layers running from one end of the entire instrument to the other. This method avoids the production, between two adjacent turns of wire, of a difference of potential sufficiently great to pierce the intervening insulation.

The interrupter, by which the primary circuit is broken at very short intervals, was improved by Ducretet, by giving it the form of a vibrating strip of metal, fixed at both ends and bearing, at its middle point a plate of soft iron. The primary current flows through this plate and a metal point in contact with it. This contact is broken by the attraction which the core of the instrument, when magnetized by the passage of the primary current, exerts upon the iron plate. But this attraction ceases as soon as the circuit is broken, and contact is then immediately re-established by the elasticity of the vibrating strip of metal. In this way a very rapid interruption is produced. Very large induction coils are usually provided with Foucault's mercury interrupter, operated by a separate battery of one or two cells.

One of the largest induction coils ever made was constructed long ago in England for Spottiswoode, by the instrument maker Apps. Its length was 48 inches; its external diameter, 16½ inches; its total weight, 1,675 pounds, and the weight of its core of soft iron, 67 pounds. The primary circuit consisted of 3,150 feet of wire of a diameter of 1/10 inch. The length of the secondary circuit was 280 miles. It consisted of 341,850 turns of wire. This apparatus, operated by 30 Grove cells, produced a spark 40 inches long.

A still larger coil was recently constructed in Paris by Carpentier. The secondary circuit of this instrument is composed of 97½ miles of copper wire of a diameter of 1/125 inch. The soft iron core has a length of 80 inches and a sectional area of 9.3 square inches. The primary coil contains 792 turns of copper ribbon, about ½ inch broad and 1/25 inch thick, arranged in six layers. The coil is surrounded by an ebonite tube more than ½ inch thick. This giant induction coil, operated by a current of 110 volts and 30 amperes, produces a spark about 50 inches in length.

The Canadian Government have appropriated $50,000 for experiments in electrical smelting, which are to be conducted under the supervision of Dr. Eugene Haanel, superintendent of mines for the Government of Ottawa.

FIRE FIGHTING WITHOUT FIRE ENGINES.

BY HERBERT T. WADE.

The practical elimination of the fire engine from fire fighting in the business section of lower Manhattan has been brought about by the successful use of the high-pressure independent fire service. Good results have attended also this modern method in Brooklyn, Coney Island, and Philadelphia, and in all of these places independent systems of high-pressure mains supplied from central pumping stations now are essential and established elements in much-needed fire protection. The frontispiece of this week's SCIENTIFIC AMERICAN illustrates the method and its application by the firemen; and while it is not intended to represent any particular plant, yet it shows the essential features of a modern high-pressure pumping station with motor-driven pumps and the use of the hydrants along the distribution system, such as are employed in New York city.

Now if a pressure of water at the hydrant can be maintained as great as that furnished by the pumps of a fire engine, then the latter of course is superfluous; and that, along with adequate water supply, is what, in short, the high-pressure system accomplishes. This condition, however, so successfully realized, has been made possible only by modern mechanical and electrical engineering, to which the firemen have added by intelligently studying and applying the new resources at their command. Referring to our illustration, it will be seen that the pumping station has two sets of intakes for its water supply—one for fresh water and the other, which is in connection with a vacuum pump, for salt water. In the case of the New York system, the Croton water is used under all normal conditions, and the mains are kept filled at the ordinary city pressure. The drafts on the city's supply for fire purposes compared with the usual daily consumption are inconsequential; but the river or salt water may be drawn at any time through intakes extending direct to the pier slips, and is available in case of any failure in the fresh-water supply or at a time of a large conflagration. For high-pressure stations either gas or electric motors are available to drive the pumps, as there is always a supply of this kind of power from public service corporations distributed underground, and carefully protected and duplicated in such a way as to make any possible failure highly improbable. Thus in the Manhattan pumping stations the high-efficiency centrifugal pumps are driven by induction motors using alternating current from the Edison Electric Company, with direct connection with its Waterside station and duplicate connection with its sub-stations, provision even being made to connect with Brooklyn in case of emergency. A contract between the city and the company requires a constant reservation of power, and the simple operation of switches puts the machinery into full operation. The centrifugal pump has been found most advantageous, particularly with electric motors.

A high-pressure system protects a given district where the mains and hydrants have been installed and in the case of New York this territory extends from Chambers to Twenty-third streets, and lies between the Hudson River and the Bowery and Third Avenue. The pumping stations are located outside of districts likely to be affected by any possible conflagration, and free from danger from neighboring buildings. They are situated at South and Oliver streets and at Gansevoort and West streets. The hydrants in this system are of the type shown in the illustration, and are spaced along the mains at an average interval of 270 feet; and to reach a building on fire, in no case would there be required a length of hose greater than 450 feet; an important consideration, as the pressure in a line of hose diminishes rapidly.

Let us assume that a fire breaks out in this protected territory, and the alarm is transmitted in the usual way, either from a street box or an automatic fire-alarm telegraph to fire headquarters. Thence it is sent out over the fire-alarm circuits to the various fire houses in the city, including the two high-pressure stations. At these stations night and day there is always an operator on duty who sits at a telephone switchboard, by which the station can be put in communication not only with the scene of fire but with headquarters and with the other station. Special telephones in metal boxes are distributed in close proximity to the hydrants through the high-pressure district, and connect direct to the station, a special service being maintained by the telephone company. In front of the operator is a large board containing the numbers and locations of the various alarm boxes throughout the district, those to which his own station responds immediately being designated in red. The alarm comes in over the regular circuit, the gong sounds the appropriate number, which is also registered by perforation on a tape, on which also is printed the time by a clock. If the alarm is one for the station, the operator immediately grasps the lever of the marine telegraph, and the signals to start are sounded and shown on the large indicator on the wall. The crew spring immediately to their places, the chief engineer at the switchboard and the oilers and machinists at their appointed stations. From the switchboard everything can be controlled and regulated. The current is switched to the motors, and the ponderous pumps are soon revolving; another switch opens electrically-controlled valves regulating the water supply, while recording and other meters and indicators are before the eyes of the chief engineer. Not every fire requires the flood of water that can be set in motion from the station, and the standing order is to start one pump, regulating the pressure at the outlet at 125 pounds. The next order must come from the chief of the fire department at the fire, and may be a call over the telephone to increase both water supply and pressure or an order to shut down the pumps. As shown in the picture, the chief at the fire is even in closer touch with the pumping station than he could be with a number of separate engines located at the scene of activity. The scene within the station when the pumps are in operation is hardly one of extraordinary activity, and no greater excitement is manifested than in a well-appointed power plant. The electric control of the chief is so complete that he does not need to leave his position at the switchboard, and with ear open for orders and eye on his meters and indicators, the entire situation is at his command.

Outside with the firemen there is naturally more activity, and high-pressure working has occasioned certain changes in equipment and methods. From the beginning the high pressure required the best and strongest hose procurable, and this in sufficient quantity is carried in large wagons. These hose carts are moved from the rear of the fire houses, from which they followed the engines, to the front and are given right of way over other apparatus in the streets. When the reliability of the high-pressure service was established, for most alarms the engines were not sent out, but held in reserve in the fire houses. In two houses the engines were entirely removed and double section hose companies maintained. As the hose is heavy, the work of carrying and hauling it is particularly arduous; so that, in this respect, the labor of the firemen at the fire has not been lightened by mechanical progress. The automobile hose wagon used by the New York Fire Department, however, has demonstrated its complete usefulness for transporting the heavy loads of 3-inch hose much more rapidly than the tenders drawn by horses. Immediately on reaching the fire, the hose is unloaded, a length connected with the hydrant outlet, of which there are four, and successive lengths are laid to the scene of action. The former engineer of the fire engine with his lever key takes his position at the hydrant, and watching the pressure gage at the outlet, opens or shuts the valves as ordered. The line is stretched where the exigencies of the occasion demand; perhaps to the standpipe connection, which must be placed at the sidewalk close to the building walls, and which connects with the standpipe itself within the building with its outlets and hose reels on each floor. It is this that affords the fire protection to a skyscraper, in addition to the pumping plant of the building, and must be used by the firemen for the higher stories, or it may be used to deliver a stream to a fire in an adjoining building. The connection may be made to the sprinkler system of the building through a similar outlet or to a cellar pipe to flood the basement, or, as shown in the illustration, two lines may be siamesed into the water tower. The permanent nozzle holders of the hose wagons may be used, while for a single stream the tripod nozzle holders are employed, as the powerful pressures render holding the hose and directing it practically impossible even for two or three firemen. The hose may even have to be hoisted up onto a fire escape, and there fastened or clamped with one of the devices which have been developed for this purpose. Now a single line from one of the four outlets is practically as powerful as that derived from a fire engine, so that the concentration of pumping power on any single block can be appreciated. Further, when it is realized that these streams can be delivered with a force sufficient to tear off cornices and make their way into the very seat of the fire, their power may be appreciated.

The New York Fire Department's use of the high-pressure system has been most successful, and quite on a par with the excellent engineering involved in its design and construction. A sufficient quantity of water is brought to bear at the earliest possible moment, and this usually quenches any ordinary fire in short order. If, however, it proves stubborn, then it is straightaway drowned out in the building where it originates, and in no case since the high-pressure service has been used in New York, has a fire progressed beyond the building where it began. In the extension of the system on the East Side of the city the distribution mains will be laid duplex in adjoining streets, passing out from the pumping station into two systems of mains, ordinarily connected but capable of being isolated by the gate valves at the station and by distant electrically-operated valves at some point of intersection. With the Philadelphia system, which incidentally uses gas motors and direct-acting pumps, in use for a number of years, and which has recently been extended, and with a well-planned project under way in San Francisco, it would seem that the day of the fire engine had passed and that the central fire protection method would soon take its place in many other large cities.

A High-Pressure Fire Reduction Valve.

Soon after the successful inauguration of the high-pressure fire service in New York city, the SCIENTIFIC AMERICAN* called attention to the need of a suitable regulating valve to be used at the hydrant, in order to render possible the control of the pressure on any single line of hose and its adaptation to the work in hand. The need of such a valve has become increasingly apparent.

For some purposes, as for a water-tower or the stand-pipe of a skyscraper, the highest pressures may be demanded, while for other lines at the same fire low-pressure streams which the firemen can hold and manipulate readily are required, as for the lower floors of the same or an adjoining building. What was needed, as was pointed out in the SCIENTIFIC AMERICAN, was a device light and portable, that could be applied readily with the hose at the hydrant outlet and enable any pressures from zero to the maximum at the hydrant to be passed with a minimum loss in volume of water from friction and otherwise.

This seems to have been secured in the Kiely and Mueller valve, which recently has undergone some thorough tests by the New York Fire Department, and has been adopted for high-pressure companies and fire-boats.

The valve is small and compact, designed to be transported on the hose tender with the smaller tools. There are two pressure gages, one on the inlet side showing the pressure at the hydrant furnished by the pumps, the other the reduced pressure as the water passes out of the valve into the line. After the hose has been stretched, the engineer opens the central valve of the hydrant with his key wrench, and then the gate valve to the outlet from which the line is taken. The handle of the regulating valve is screwed down, allowing no water to pass. A half turn of the handle in the direction of an indicating arrow allows water at a pressure approximately of 15 pounds to pass, a full turn 30 pounds, and so on up to the full or hydrant pressure. In short, the pressure on any line from such a valve is entirely under control, and the engineer merely has to watch his gage and *turn* his handle until the desired point is reached, when the pressure is maintained automatically.

In a recent test before the engineers of the New York Department of Water Supply, Gas, and Electricity witnessed by the author as the representative of the SCIENTIFIC AMERICAN at the St. Edwards High Pressure Station in Brooklyn, it met every condition imposed. Different pressures from 75 to 300 pounds were put on the mains by the pumps in the adjacent station, and the pressure on the line was reduced as ordered by simply turning the handle of the valve. Thus when over 240 pounds was recorded at the hydrant, 40 pounds was delivered at the nozzle. The adjustment and maintenance of any desired pressure were far more easily and satisfactorily controlled than would be possible with a steam fire engine. Variations in the pressure on the mains did not affect sensibly the operation of the valve, while when the line was shut down at the nozzle no effect was manifest.

The valve consists essentially of a valve body, containing a seat; main disk; piston; auxiliary valve; a diaphragm; a compression spring; an adjusting screw; a handle; and a small hand-operated by-pass valve. The disk and piston are constructed of one piece, and the portion of the metal connecting the disk and piston has in it a small port through which high pressure passes up over the piston, which, being of greater diameter than the disk, drives the latter down to its seat, thus shutting off the pressure. The next part of the operation is brought by the opening of the auxiliary valve mentioned above, which being of greater diameter than the port through which the high pressure is conveyed to the top of the piston, quickly causes a reduction of pressure on the piston side sufficient to allow the initial pressure to open the main valve or disk. As soon as the reduced pressure has become sufficient to force the diaphragm up against the pressure exerted by the adjusting spring, it causes the auxiliary valve to close, thereby bottling up the pressure above the piston, which, owing to its greater area, causes the main valve to close. This operation is repeated as often as occasion may require. The function of the small by-pass valve also mentioned is to enable it to cause full pressure to flow through the valve when desired, as in a sudden emergency. The power to operate the valve is furnished by the initial pressure, whereas in most reducing valves it is the reduced pressure acting on the diaphragm that is connected to the main disk.

* November 7th, 1908.

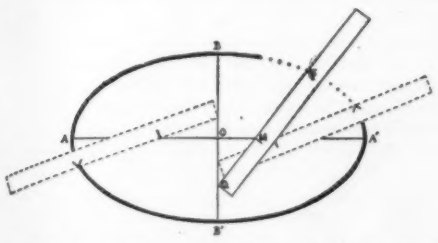
Correspondence.

A SIMPLE METHOD OF CONSTRUCTING AN ELLIPSE.

To the Editor of the SCIENTIFIC AMERICAN:

In your issues of July 14th and August 25th for the year 1906, two methods are suggested for drawing an ellipse with the aid of a compass. But the compass has never produced a true ellipse, and these results are merely close approximations. Also, in the last-named issue, there is a method for constructing an ellipse by means of a network of tangents. This method also was proved inaccurate by Mr. Warwick Worthington in the number for July 31st, 1909; and he in turn offers a solution by a network of tangents which I believe gives a perfect ellipse, although the method is somewhat cumbersome for ordinary use.

There is, however, a simple way of constructing an ellipse of any desired dimensions solely with the aid



A SIMPLE METHOD OF CONSTRUCTING AN ELLIPSE.

of straight-edge and pencil. No originality belongs to my method; but it is readily proved to accord with correct mathematical principles.

On a straight-edge or ruler mark off a distance QP, equal to half the desired major axis; also, from point P, a distance PM, equal to half the desired minor axis.

Referring now to the drawing, we construct perpendiculars AA' and BB', and lay the ruler down so that the points Q and M fall exactly upon these perpendiculars. The point P will then fall somewhere on the curve of the proposed ellipse. By shifting the ruler about, in such a way that Q and M always fall on lines AA^1 and BB^1, respectively, the mark on the ruler at P will give the position of any number of points, which afterward may readily be joined by a continuous line. EDWARD M. WEYER.

Washington and Jefferson College, Washington, Pa.

Astronomical Photography.

BY F. V. COLLINS.

The plan of photographing the entire heavens originated with Mouchez in 1887. The death of this eminent man of science was one of the adverse factors which have conspired to delay the work, which now, however, promises to draw to a triumphant conclusion.

The importance of the universal photographic star chart to the astronomer of the future cannot be overestimated. It is now generally acknowledged that the stars are in motion with respect to one another, and our entire solar system is in motion through space, so that one day the constellations will be seen from a sensibly different point of view. Changes will come to pass in the apparent arrangement of the star groups, and in the course of years they will develop, so that something may ultimately be discovered of the real structure and laws of the distant bodies of the universe. It may be that the chart now being prepared will enable the astronomer of some centuries hence to learn as much of the great universe of stars as we know of our comparatively minute solar system revolving within it.

Though photography has been demonstrated of late years to be the only method of revealing the structure of those fascinating formations, the nebulæ, at all adequately, the star chart on a large scale, though it be more prosaic to lay observation, possesses an incalculable value of itself. The wonderfully accurate photographic chart may lead, with the aid of a correspondingly accurate system of measurement, to the discovery of entirely new laws of the universe which directly affect our own planet. Seth Chandler discovered the law and evaluated the magnitude of an oscillation in the position of the axis of the earth's figure, which had for years puzzled his astronomical colleagues, not as a result of any special series of observations made for the purpose, but upon the examination of measures made for divers ends at numerous observatories throughout the whole of the last century. And so it has always been a result of measurement when any great advance has been made in a knowledge of the laws which govern the universe. So it will have to be in the solution of the problems which confront astronomers to-day in every direction. The photographic chart, by making these measures more rapid and more certain than is possible by the old visual method, has practically revolutionized this most valuable field of astronomical research.

The reason of the superiority of the photographic chart over the older method of observation is quite simply explained. The image of a star in the telescope is very rarely absolutely steady, for the light, prior to its reaching the instrument, has to pass through the veritable sea of our own atmosphere, constantly disturbed, in practically all portions, by cold and hot-air currents. Rifle shots are familiar with the sort of effect which is thus produced. On a blazing hot day, when currents of air are rising from the heated ground, the target seems to dance before the eyes, growing taller and shorter and breaking in pieces, with the bull's eye now in one corner and now altogether vanished. Something of the same thing happens to the star image when the telescope is set up in any but a very few tranquil places, and especially when it is in a country much broken up by mountain chains or arms of the sea. On all but two or three nights in the year the star image will be seen dancing and quivering in the telescope, more or less as the air is much disturbed or uniform. And when the observer tries to set the spider line of his measuring apparatus upon the image, he has to make some sort of estimate of its mean position and set upon that. It is really surprising how accurately this can be done after long experience, but the unsteadiness of the object is bound to set a limit to the accuracy which even the most practised observer can obtain. Now it might be thought that this constant vibration of the object would be more fatal to the photograph than to visual observation, but this is not the case. For the motion is very rapid; several times a second does the star make a small jump from its mean position and return to it, and, on an average, it jumps every way with equal frequency. The consequence is that the photographic plate, which keeps a record of every jump, produces in the end an image which is certainly larger than it ought to be, but which is, as a rule, enlarged equally in every direction, so that its center remains still where the center of the image belongs. And when the plate is put under the microscope of the measuring machine—a device capable of accurately determining a fifty-thousandth of an inch—and the threads which are moved by the measuring screw set upon the photographed image, the enlargement of the latter is more than compensated for by any advantage which accrues from a steady image.

But the superiority of the astronomical photograph over visual observation is not confined to the star chart. Numerous articles in popular periodicals have acquainted the general reader with the wonders of the nebulæ as revealed by the photographic plate. The cumulative effect of light upon the latter renders it possible to obtain exquisite delineations of faintly luminous objects by means of a sufficiently long exposure. Vast new regions of space are thus being explored; and still vaster regions await further exploration. Prof. E. Ray Lankester, in an address before the British Association, stated that "the invention of the dry plate, which has made it possible to apply photography to astronomical work, is the chief cause of the great expansion of astronomy since 1881." To quote Prof. Lankester further: "It was the dry plate which made long exposure possible, and thus enabled astronomers to obtain regular records of faintly luminous objects, such as nebulæ and star spectra. Roughly speaking, those visible to the naked eye may be stated as 8,000; this is raised by the use of the best telescopes to 100,000,000. But the number which can be photographed is indefinite, and depends on length of exposure; 1,000,000,000,000 can certainly be so recorded. By the photographic method hundreds of new variable stars and other interesting objects have been discovered. New planets have been detected by the hundred. Up to 1881, 220 were known. During 1881 only one was found, namely, Stephania, being No. 220, discovered on May 19th. Now a score, at least, are discovered every year."

The appearance of Halley's comet this year suggests the fact that some of the most extraordinary revelations of photography in astronomy have been in the case of these strange members of the solar system. The vast size and tenuity of comets render them very liable to disturbances from other celestial bodies. The photographic plate has shown that the comets utterly transform themselves in a few hours' time. These transformations are sometimes evidently due to gravitation from some neighbor, and again, apparently, from actual collision with planetary bodies or matter, which not only distorts but sometimes breaks the tail. This was the case with one of the comets of 1893, where photographs on successive nights show the tail dissipated and broken, evidently by such an encounter. The presence of a new planet or of inter-planetary substance may be thus revealed. It is interesting to note that the present appearance of the comet of Halley will signalize the first occasion on which this famous body has been photographed.

According to Prof. G. W. Ritchey, of the Yerkes Observatory, it is now possible, with the aid of improved optics and mechanics, to construct a photographic reflecting telescope with as much precision and refinement as have been expended upon the great refracting telescopes. Prof. Ritchey has obtained splendid results from his two-foot photographic reflector, and his photographs thus obtained of the nebulæ have a wider appeal than to the scientific mind alone. To many a person untrained in astronomical lore, indeed, the photograph of the great spiral nebula in the constellation of Andromeda, obtained with the Yerkes two-foot reflector, would probably appeal at once as that of a most marvelous spectacle—a vast planetary system in the making. About the same proportion of the sun to the planets in our own system is to be observed in the great central spherical condensation of the whirling mass and the smaller condensations in the latter. Some of these smaller condensations, at varying distances from the central semi-formed orb, have assumed an almost perfectly spherical shape; others, again, are formless, though vastly denser than the nebulous matter extending, in a circular or elliptical form, throughout the entire spiral system. It may be observed that the spiral character of this nebula was never even suspected until it was photographed in 1888 by Roberts with a reflecting telescope. Yet the result then obtained was crude indeed when compared with what was obtained by the instrument at the Yerkes Observatory. Seen by the naked eye, this great nebula appears only as an indistinct hazy spot among the stars. The greatest visual telescope in existence fails utterly to reveal the amazing spiral structure so brilliantly shown in the photograph.

Judging from the results obtained with the two-foot instrument, Prof. Ritchey estimates that an eight-foot reflector, if used in a climate where there are suitable atmospheric conditions, would photograph stars which are fifty times fainter than the faintest stars which can be seen with the largest modern refractors. "This means," says Prof. Ritchey, "that such a reflector would enable us to penetrate seven times farther into space than can now be done with the greatest visual telescopes, and therefore that such an instrument would reveal to us a universe seven times seven times seven—more than three hundred—times greater than the universe which is revealed by the most powerful modern refractors. . . . I know of no opportunity which has ever been presented in the entire history of astronomy greater than that which now awaits us in the construction of a large modern reflector and its use in astronomical photography."

It is estimated that the cost of such an instrument as Prof. Ritchey advocates—that is, one of eight-foot aperture, and embodying the latest developments in optics and mechanics—would be about one-thirtieth that of building a battleship of the "Dreadnought" type.

The Current Supplement.

One of the most important articles in the current SUPPLEMENT, No. 1796, is that by George Neumann, in which the compulsory working of German patents is discussed, a matter of great importance to American manufacturers. The adhesion of locomotives is a most important factor in designing engines, and must be considered at every step in the preparation of a general design. An article on this subject appears in the current SUPPLEMENT. Roze's excellent description of a profile puppet-show, and how it can be made and used, is continued. When shipbuilders commenced turning out iron and steel vessels, navigators found themselves confronted with the problem of overcoming the magnetic forces of their ships, and making their compass needles point toward the magnetic north. How the problem is solved is told by William C. Ward in a paper entitled "Compass Deviations." Frank C. Perkins writes on Canadian pulp making in the Algoma district, Ontario. Irish linens and some features of their production are discussed by Sir William Crawford.

Three kinds of bench marks were used by the United States Geological Survey in the spirit leveling in Ohio from 1898 to 1908, inclusive, according to a bulletin by Messrs. S. S. Gannett and D. H. Baldwin. The first form was generally used in the vertical walls of public buildings, bridge abutments, or other substantial masonry structures, being a circular bronze or aluminium tablet, 3½ inches in diameter and ¼ inch thick, appropriately lettered, and having a 3-inch stem cemented into a drilled hole. The second form was employed where masonry or rock formation was not accessible, and consisted of a hollow wrought iron post, 4 feet long and 3½ inches in outer diameter, split at the bottom and expanded to 10 inches so as to resist pulling from the ground. These posts were sunk 3 feet in the ground—after having been coated with asphalt—and a bronze tablet similar to the one already described was then riveted to the top. The third form was little used and is now altogether discontinued, being the ordinary split bolt of copper, 1 inch in diameter and 4 inches long.

HOW TO ESCAPE FROM A SUNKEN SUBMARINE

METHODS APPROVED AND DISAPPROVED

In a diving manual recently published by Siebe, Gorman & Company, Limited, submarine engineers of London, we find some excellent suggestions on the subject of saving the crews of submarine boats.

The problem of saving the lives of a crew of a submarine vessel is by no means easy of solution. The equipment and apparatus which is invaluable on shore is quite useless under water. It would be quite easy to construct a submarine boat, the crew of which would be safe under practically every conceivable set of circumstances, but such a vessel would be so hampered by her safety devices as to have little or no military efficiency. In the opinion of Messrs. Siebe & Gorman it is essential that the salvage of the vessel and of the crew must be looked upon as entirely separate. Inevitable delays in the arrival of the salvage vessel and in getting purchase on, conditions of tide, weather, etc., render it almost certain that a submarine cannot be raised in time to save life.

It is taken for granted that an accident which will endanger the lives of the crew will result in the inrush of water in large quantities. A minor accident to the machinery would result only in an involuntary rush to the surface, owing to the reserve buoyancy of the boat, and any ordinary small leakage can be readily dealt with by the machinery at command.

When, however, there is a collision, or when, by some other mischance, a hole is made in the hull, the water enters freely, and the effect will be the descent of the vessel to the bottom. This may not be very fast, but, assuming that the water is entering more rapidly than it can be expelled, the vessel will undoubtedly sink and continue to fill, until she is either full, or, if not holed in the top, until the aid in her is compressed to a pressure equal to that of the water at the depth in which she has foundered. As soon as the salt water comes into contact with the battery or with the terminals of the dynamo, if this be still working, chlorine is evolved, and the air remaining inside is vitiated.

If anything is done, it must be done quickly. Accordingly, the following steps must be taken:

(*a*) To render the crew independent of poisonous gases,

(*b*) To preserve the crew from drowning in the boat, and

(*c*) To provide means of escape from the boat, and ascent to the surface.

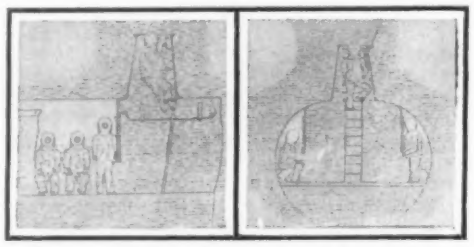
The devices to bring these about at present known are:

(1) Air locks for escape.

(2) Detachable chambers or life boats.

(3) Self-contained dress for escape.

Air locks alone are of little use, except in shallow water, but combined with (2) or (3) are essential in all methods of escape. The air lock may be a portion of the boat provided for the special purpose, or the general cavity of the boat may be used, in which case the pressure inside the vessel can be made equal to that of the water outside by simply allowing the water to enter, for it is manifestly impossible to open an aperture until the pressures at both sides of it are equal. The great objection to all forms of detachable chambers or life boats is their size, weight, and resistance. If made large enough to contain all the crew of a modern submarine, and as such a chamber would have to be carried as a superstructure, it would be in the likeliest position to be injured in case of collision. Moreover, what is further against any device of this kind is that the crew are expected in a moment of considerable excitement to undertake an entirely novel operation which there is no means of trying previously. Experience has shown that even plain drop safety weights fail at the critical moment.



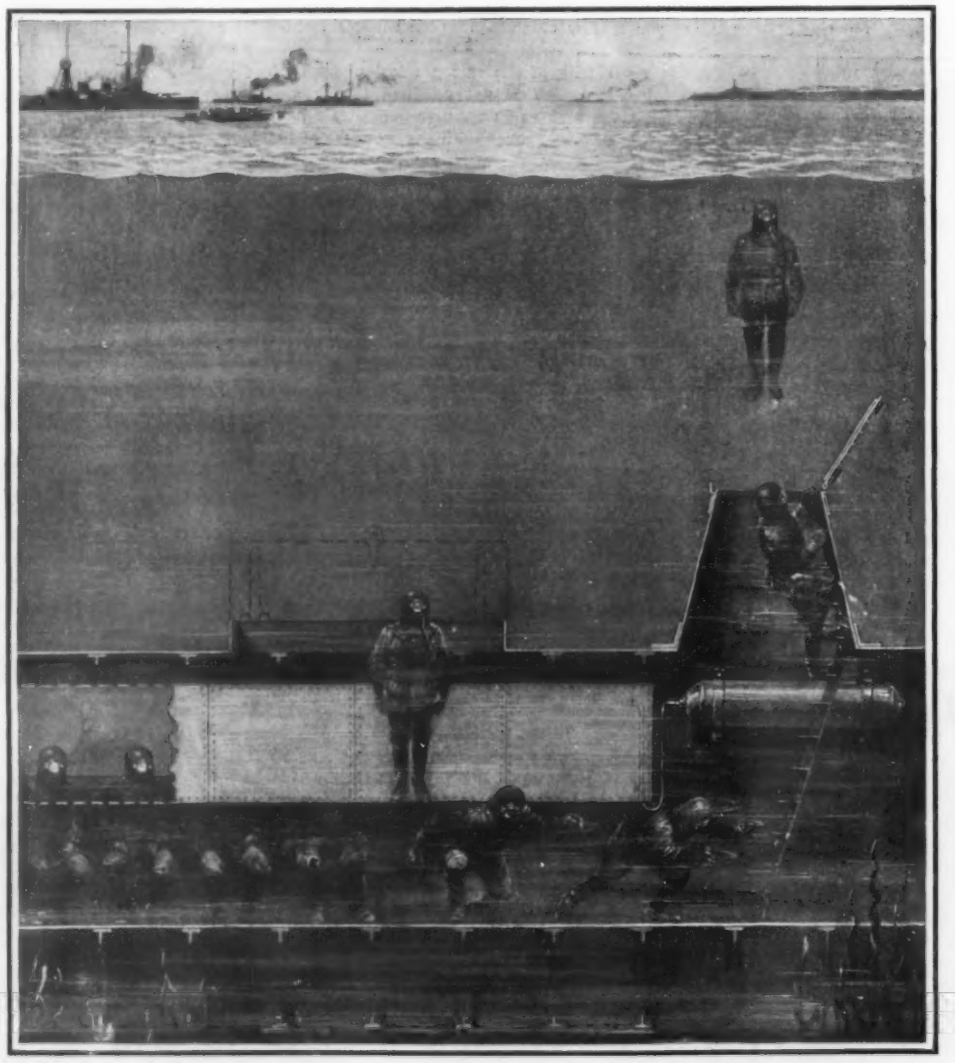
The diagram on the left shows a longitudinal section of a submarine, showing an air-trap in use, three men under the trap in safety helmets, and one emerging from the conning-tower; that on the right a transverse section of a submarine, showing air-traps in use; men seated in the air-traps, wearing safety-helmets, and a man emerging from the conning-tower.

VARIOUS METHODS OF ESCAPE.

A life-saving device to be efficient must be able to fulfill promptly the three conditions, *a*, *b*, and *c*, previously referred to, and in order to meet them a special form of diving helmet has been designed by Messrs. Siebe & Gorman which is quite self-contained and not dependent on any feature which is liable to get out of order. The helmet, which is large enough to allow the head free movement, is sloped away to fit the shoulders, and is connected to a short jacket of strong waterproof material. In front of the jacket, inside, is a pocket containing a combined air purifier and oxygen generator, consisting of two small chambers formed in one case. These chambers are charged with a patented substance which, when in contact with the water vapor of the breath, gives off pure oxygen gas and forms a caustic alkali. The alkali in its turn takes up the carbonic acid gas of the respired air and forms an alkaline carbonate. In this way, as in various types of smoke helmet, the same air, purified and re-oxygenated, is used over and over again. The total weight of the whole outfit is 16 pounds. Folded up for stowage, it occupies a space of 12 inches by 12 inches by 15 inches. The dress can be put on without assistance in 30 seconds. When on it prevents a man from drowning, and in proof of this it may be said that it is now in everyday use under water with perfect success. Moreover, it acts as a life buoy, and actually raises its wearer to the surface. An additional device is also fitted to enable the wearer when he reaches the surface to inflate a flexible chamber which surrounds the jacket and thus to form a life belt. This provision is necessary, for the length of time the purifier will remain in action is limited, and when its efficiency is impaired the door in the helmet must be opened, which operation can be performed by the wearer, in order to admit fresh air. When this is done the helmet ceases to be buoyant. Other methods, such as the fitting of cork belts or chambers already filled with air, have been tried and abandoned, being found to be impracticable, owing to the necessity of employing heavy weights to keep the wearer down, and also by reason of the dangerous velocity with which he would rise to the surface on the removal of the weights.

At Portsmouth the British Admiralty have in use a huge water tank, at the bottom of which is erected a skeleton submarine boat, serving the purpose of permitting the men to exercise in the helmet described. The men having first been trained to put on the dress quickly are set to practice getting into and out of the air lock. They are afterward lowered in the air lock to the bottom of the tank, where they enter the submarine, and find their way to a ladder leading to the conning tower, the hatch of which they open. They then either float to the surface or return to the starting point, the operations being repeated until the officer in charge considers the men proficient. These arrangements have been designed to represent as nearly as possible the same conditions as would obtain in a submarine boat that had been flooded.

If the hole in the submarine be at the top, the water will gradually displace the whole of the air. If, however, the hole is below the top, then the water will only enter until the air, which cannot escape, has been compressed until its pressure is equal to that of the water outside. In the latter case there is no difficulty in getting at and putting on the helmet dress, since there is air inside the hull. In the former case, however, unless some special provision were made, this would not be so, and, accordingly, bulkheads are arranged to trap the air. The dresses are kept hanging up in readiness in the air pockets so formed. This does not in any way affect the habitability or efficiency of the vessel. It is claimed, further, that the apparatus makes an excellent shallow water diving dress, though in this case the man has to be weighted, and that it is also efficient as a smoke helmet.



By courtesy of Illustrated London News.

The boat having sunk to the bottom, air will be compressed either under the deck of the vessel itself or under the air-traps. Beneath the air-traps the men, having put on their special diving-helmets, sit, with their heads in the compressed air, until it is their turn to escape, either through the conning-tower or through the torpedo-hatch, and rise to the surface. In front of each waterproof jacket, attached to the diving-helmet, is a pocket containing a combined purifier and oxygen-generator, which enables the same air, purified and re-oxygenated, to be used again and again. The dress, which can be put on in thirty seconds, not only prevents the suffocation of the wearer, but acts as a life-buoy. There are fitted to the air-traps air-supply pipes from the boat's compressed-air cylinders, so that an extra pressure of air may be turned on when necessary. The drawing shows men, wearing safety-helmets, waiting under an air-trap in a submarine; men leaving the air-trap to ascend the conning-tower; a man leaving the conning tower to float to the surface; and a man escaping through the torpedo-hatch.

HOW MEN ESCAPE FROM A SUNKEN SUBMARINE.

ARTIFICIAL RADIUM BATHS AND DRINKING WATER

BY DR. ALFRED GRADENWITZ

Until quite recently the curative effects of mineral waters were ascribed to the chemical substances held in solution. The lack of mineral solvents in some waters of remarkable therapeutic value could not be explained on this principle. Moreover, for some unaccountable reason it was observed that most waters lost their healing properties when taken at some place distant from their source.

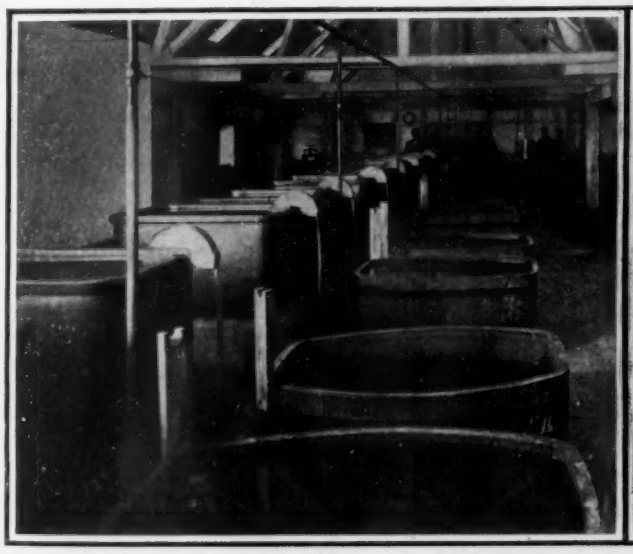
All these contradictory phenomena can now be plausibly explained by ascribing part, if not all, of the curative power to radioactive substances. In fact, nearly all mineral waters have been found to contain radioactive emanation. This emanation being an extremely unstable body, most waters lose their activity in a few days, so that the curative agent cannot exert its action unless the water be administered as soon as possible after issuing from the ground. Only a few waters, containing radioactive substances capable of giving off a constant supply of emanation, have been found to keep at least part of their activity for any length of time.

This tracing of efficacy to radioactivity naturally suggested the artificial control of radioactivity so as to impart curative effects to inactive water or to increase the efficiency of natural springs. The idea of adding variable amounts of emanation has been car-

(*Continued on page 468.*)

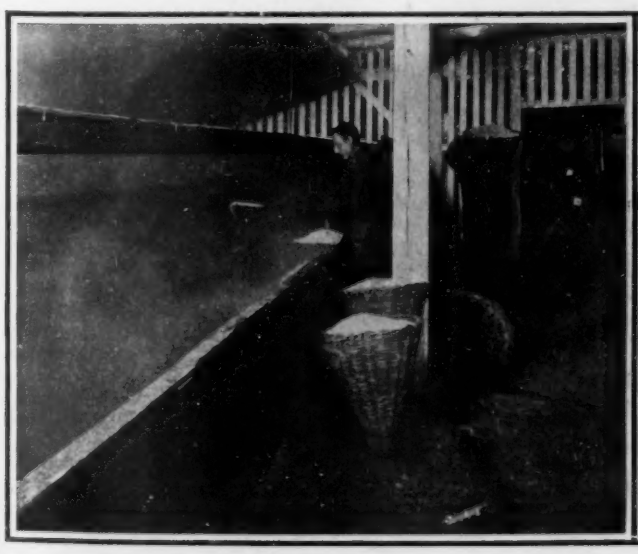
Laboratory for obtaining highly concentrated radioactive substances.

Laboratory for coarse chemical processes.

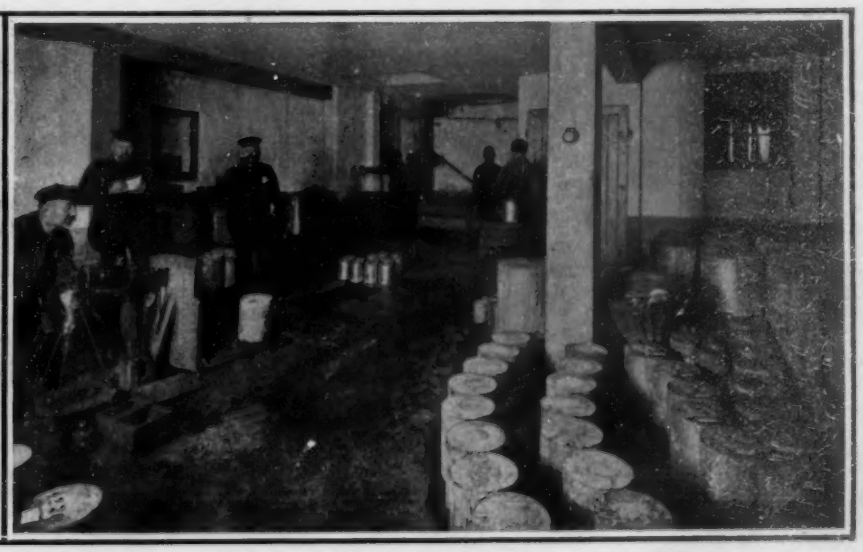


Washing plant for radioactive substances treated by chemical processes.

General view of the famous Kreuznach valley.



Removing the crystallized salt from a boiling pan.



Mother liquor shipping room.

ARTIFICIAL RADIUM BATHS AND DRINKING WATER.

ALEXANDER GRAHAM BELL AND THE TELEPHONE

THE STORY OF A GREAT INVENTION

The telephone was first introduced to the public in 1876, and put to the first practical or commercial use in 1877. During that year was organized the first association or company to hold the patents. The first companies which systematically exploited the business were formed in 1878, one for New England and one for the rest of the United States and Canada. These two companies succeeded to all the rights and property of the original association. The capital represented $750,000, the value of the patents, and $100,000 in cash. Early in 1879 these two companies were consolidated into one company called The National Bell Telephone Company, the first company to attain any prominence. The capital of this company was $850,000, deposited among 8,500 shares of $100 par value each. The sum of $650,000 in shares was given, share for share, for the stock of the two old companies, and $200,000 in shares was left in the treasury. This treasury stock was sold for the best price obtainable, as the money was required, and yielded eventually $430,000 in cash. The last 500 shares of this treasury stock sold for $600 each. In the fall of 1879 a settlement was effected with the Western Union Telegraph Company, whereby the most formidable and powerful competitor was removed from the field. Then it was that the stock boomed. The $100 shares, of which there were only 8,500, were quoted at one time at $1,000, although that price was probably never actually paid. At the highest quotation, a total market value of all the shares of the company would have been $8,500,000. According to popular belief, twelve of the original investors have been credited with realizing, if not more, at least as much as this, yet no dividends were paid by this company.

Because of the rapid increase in business, more capital was required; hence in 1880 the American Bell Telephone Company was organized and the business of the National Bell Telephone Company transferred to it. The shareholders of the National Bell Telephone Company were given for each share of their stock six shares of the new American Bell Telephone Company's stock. At the same time, 8,500 shares of the treasury stock were sold at par. In 1881 the first dividend was paid.

The American Bell Telephone Company continued in business until 1899, during which time the capital stock had increased from $5,950,000 to $25,886,300. When the American Bell Telephone Company transferred its business to the American Telephone and Telegraph Company, there had been over $28,000,000 actual cash paid into the treasury of the company by the shareholders as against $25,886,300 capital outstanding. During the time no stock dividend or a dividend of surplus in cash to pay for stock issued was paid. The market price of the American Bell Telephone Company's shares during the year ranged above $200 a share, and the company was paying 15 per cent dividends yearly.

The demands of the business required much larger capital than could be provided under the corporate powers of the American Bell Telephone Company. Hence, the American Telephone and Telegraph Company was organized to operate the long-distance traffic, and to it the business was transferred in 1899. The dividends were put on a 7½ per cent basis, and were increased in 1906 to 8 per cent, at which rate they still continue. Since 1900 the stock of the American Telephone and Telegraph Company has been increased from time to time as the business called for money. At the close of 1909 there were in the hands of the public $206,474,300.

This tremendous industry is the fruit of Mr. Alexander Graham Bell's indomitable and persevering work as a young man. His story of the invention of the telephone is a story of patient endeavor and experiment, continued for years in the face of many difficulties. He approached the subject more or less an expert in speech, for both his father and grandfather had been teachers of articulation and the laws of speech, and he had himself been educated to follow in their footsteps. In boyhood he constructed a talking machine. At the age of eighteen he made discoveries which he thought original concerning the part played in the production of vowel sounds by the resonance of the cavities of the mouth. It was not long before he learned that Helmholtz had not only made the same discoveries, but had produced the sounds of the vowels by combinations of tuning forks, operated by electro-magnets. In order to repeat Helmholtz's experiments, Bell began to study electricity. In 1872 he constructed an experimental apparatus in which each transmitter consisted of a tuning fork with its prongs between the poles of an electro-magnet. Current was applied intermittently by means of a wire which was attached to one prong of the fork and alternately made and broke the contact with a cup of mercury as the fork vibrated. As the prongs of the fork were attracted by the magnet each time the current was applied, the fork was kept continuously vibrating and sounding. By pressing a telegraph key, the intermittent current was sent through the line wire to the receiving instrument, which consisted of another electro-magnet and tuning fork. If the receiving fork was exactly in unison with the transmitting fork it was also thrown into vibration, but if it was not in unison it remained silent, because the portional currents did not reach it with the proper frequency to cause it to vibrate. It was Bell's idea to use several transmitting forks of different pitches, and as many receiving forks of the same pitches. As each transmitter would affect only the particular receiver that was in unison with it, a number of telegraphic messages could thus be sent simultaneously over a single wire. Afterward Bell substituted for the tuning fork a steel plate or reed, with one end clamped and the free end very near the poles of the electro-magnet. The transmitting reed, like the tuning fork which it superseded, definitely made and broke contact, and thus made the current intermittent, and the receiving reed vibrated energetically only when it was in unison with the transmitting reed. Still later Bell conceived the idea of polarizing or magnetizing each reed by clamping it to a pole of a permanent magnet, allowing its free end to project, as before, over the poles of the electro-magnet. He knew that the vibration of the magnetized reed would induce currents in the coils of the transmitting electro-magnet and that these currents, reaching the receiving electro-magnet through the line wire, would set the reed of the receiver into vibration if the two reeds were tuned to exact unison. This arrangement dispensed with the galvanic battery and the mercury circuit-breaker. The circuit was never broken and the current, instead of being intermittent, was undulatory, varying in intensity and direction in exact accordance with the motion of the transmitting reed. The two instruments were exactly alike, and either could be used as the transmitter. Several such pairs of instruments, of different pitches, could be employed, with a line wire connecting the two stations, and the plucking of any reed, at either station, would theoretically cause the reed of the same pitch, and that reed only, to "speak" at the other station, so that a number of messages could be transmitted simultaneously in each direction. Bell, however, thought that the currents thus generated by the vibration of the reeds would be too feeble for practical use in multiple telegraphy and he therefore turned his attention to a system which included a battery and a mechanical circuit breaker.

Meanwhile, in connection with his professional work, the instruction of deaf mutes and their teachers, Bell had been experimenting with the phonautograph, an instrument devised by Leon Scott for making visible records of the vibrations of sound. The short arm of a light wooden lever was attached to a membrane stretched over the small end of a funnel, and the long arm terminated in a bristle which touched a sheet of glass, covered with lamp-black, which was drawn along at a uniform speed. When a sound was uttered into the funnel the sound waves caused the membrane to vibrate and the bristle to trace on the smoked glass a sinuous curve, which represented the vibration so exactly that not only every pitch but every quality of voice, and each of the vowel sounds, produced its characteristic tracing. The principles of the phonautograph is almost identical with that of the phonograph. Bell discovered defects in the instrument, and as he labored to remove them, it occurred to him that the best form of phonautograph would be an imitation of the human ear, in which the sound waves are likewise received by a membrane, the ear drum, and the vibrations are transmitted to the inner ear by a series of bone levers. Dr. Blake, an aurist to whom Bell applied for precise information concerning the structure of the ear, suggested the employment of a real human ear instead of an imitation. An anatomical specimen was prepared, with a fine straw attached to one of the bone levers to serve as a writing point, and Bell experimented with it in 1874, while he was still working with his reeds and electro-magnets.

Another possibility had occurred to him. He knew that when a vowel sound is sung into an open piano all the strings that correspond to the overtones, which give the sound its vowel quality, as well as the string corresponding to the fundamental tone, are set into vibration, so that the piano repeats the particular vowel uttered. In like manner, the transmitting reeds, if sufficiently numerous, might take up from the air the component simple vibrations of a vowel sound and transmit them by means of the electro-magnets and the line wire to the receiving reeds, which would reproduce the vowel sound at the distant station. Bell also considered the possibility of employing, at each station, one large electro-magnet instead of many small ones, in connection with all of the reeds, and thus combining the elementary electrical vibrations, corresponding to the components of the aerial sound waves, in the coil of the electro-magnet, instead of in the line wire. "In this way," the inventor has said, "I realized in the summer of 1874 the conception of a speaking telephone, and the apparatus is the first form of speaking telephone that occurred to my mind." But it seemed impracticable to construct an apparatus with a sufficient number of reeds, and so that "harp" telephone was never realized. Then it occurred to Bell that the resultant electrical effect in the coil of the electro-magnet might be produced by a single reed, if this reed could be formed to move in accordance with the resultant sonorous vibration. While studying this problem he was experimenting with the phonautograph made from a human ear. He was struck with the lightness of the ear drum in comparison with the weight of the bones moved by it, and it occurred to him that a larger membrane might move a piece of steel in the desired manner. He proposed to attach

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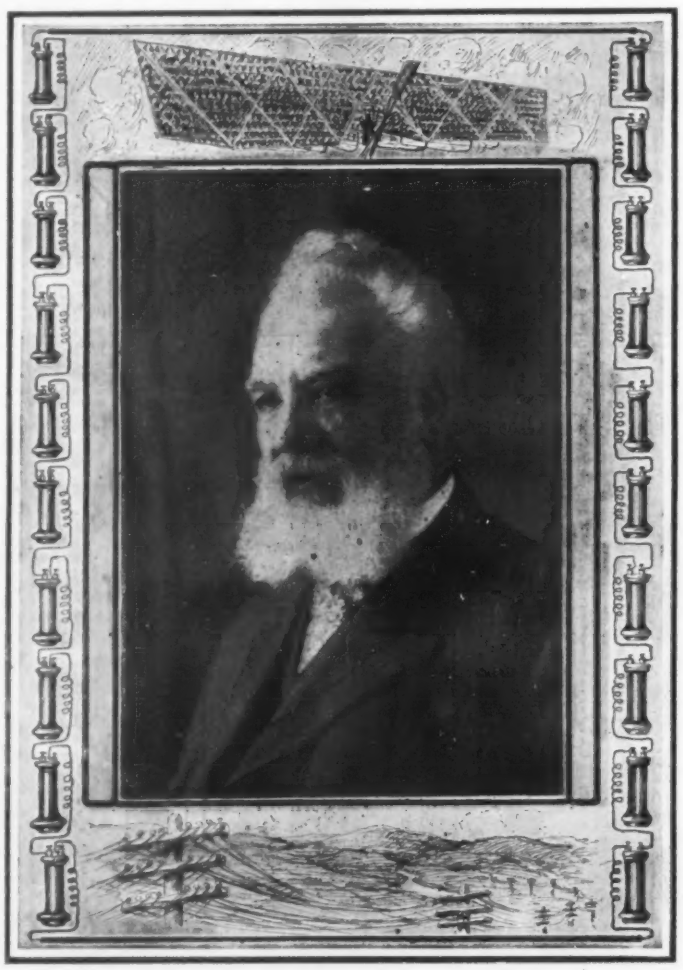

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ALEXANDER GRAHAM BELL.

A MOTION APPARATUS FOR AMATEURS

AN INGENIOUS FRENCH INVENTION

The production of photographs of moving objects has hitherto been denied to amateurs, for various reasons. It requires complicated and costly apparatus and delicate manipulations which cannot be performed without special appliances.

A simple apparatus, called the Cinephote, has been devised to obviate these difficulties and to put motion photography within the power of every amateur photographer, at least to the extent of producing animated portraits of his friends and his children, for the Cinephote does not pretend to vie with the elaborate apparatus by which thousands of instantaneous photographs of a long and complex scene are impressed on hundreds of feet of film.

small perforations, causes the disk to rotate intermittently, pausing after each advance long enough for a single exposure. At the same time the shutter is automatically caused to open when the disk stops and to close when it resumes its rotary movement. For the disk containing 24 pictures arranged in a circle, the bearing is fixed at the center of the plateholder, but for the disk with 75 spirally arranged pictures, the bearing is free to move in a vertical slide and, as the reciprocating pin engages successively with the spirally arranged perforations, the disk is displaced in such a manner that each picture is made in its proper place in the spiral curve. In either case the movement of the mechanism is automatically arrested when

work and essentially similar to the mechanism employed in making the negatives. But, as only a very fleeting illusion is thus produced by the disks which contain 24 pictures, there is provided, for these disks alone, another apparatus which can be turned by hand, slowly and for an indefinite time, showing the pictures repeatedly in their proper order. A third form of apparatus is furnished for the purpose of projecting the pictures on a screen with a lantern.

A writer in a contemporary refers to numerous failures of cast-iron fittings, which were, however, of the usual run of commercial extra heavy fittings, of which neither the metal nor the thickness were sufficiently

Fig. 1.—Disk with 24 pictures.

Fig. 2.—Watching the motion pictures.

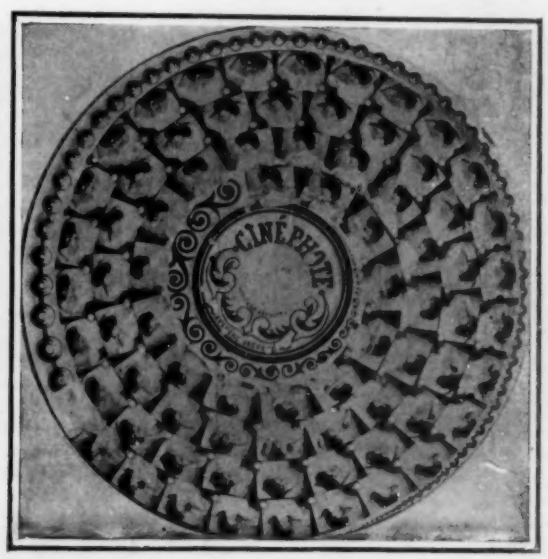


Fig. 5.—Disk with 75 pictures.

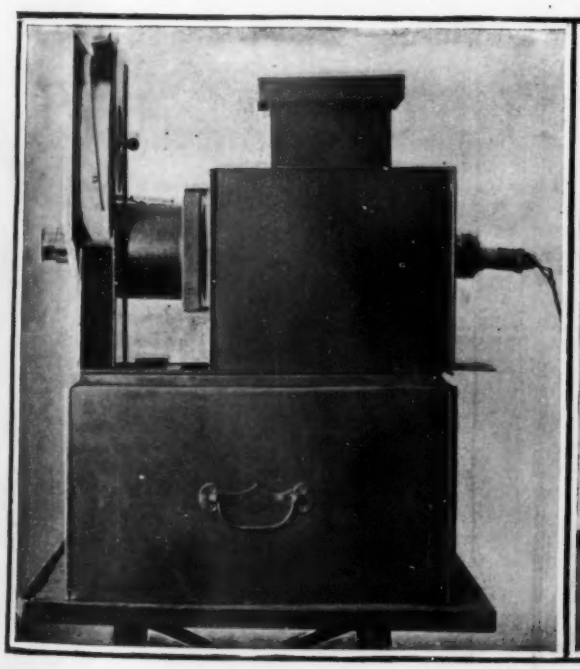


Fig. 4.—Apparatus for projecting the motion pictures.

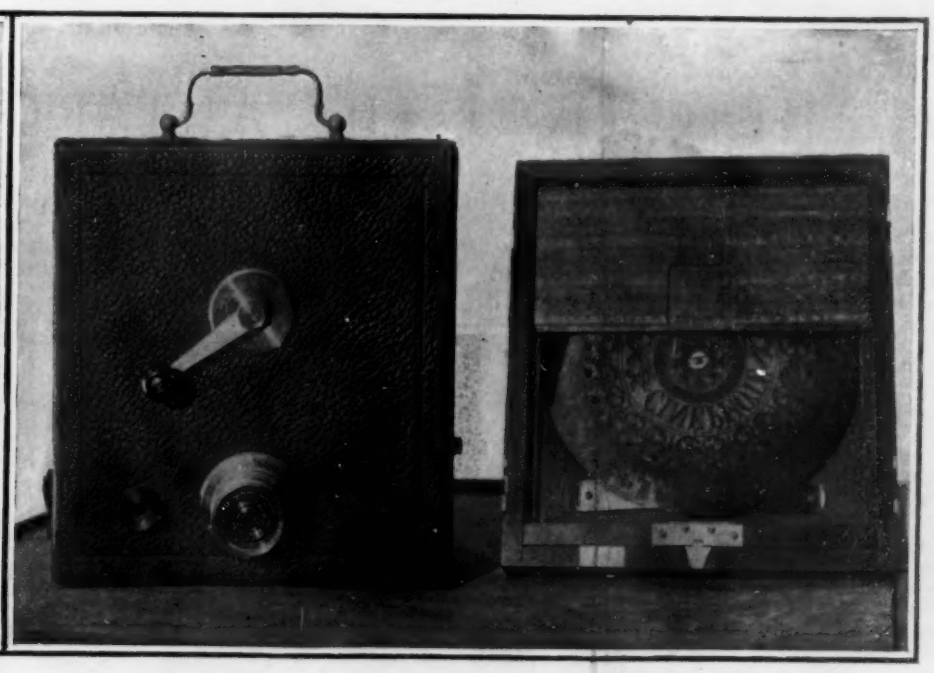


Fig. 3.—Cinephote camera and plateholder.

A MOTION APPARATUS FOR AMATEURS.

The Cinephote comprises two distinct pieces of apparatus: one for making the pictures, the other for exhibiting them in such a manner as to give the illusion of movement. Both of these devices work automatically, by means of very simple mechanism. The negatives, which are either 24 or 75 in number, are made on a circular sensitized plate, on which the 24 pictures are arranged in the form of a circle, while the 75 pictures are arranged spirally, as the accompanying illustrations show. In either case, the disk is perforated with small holes, equal in number to the pictures, and distributed at equal angular distances along the same curve—circle or spiral. By means of a larger hole at its center, and a corresponding peg, or bearing, in the plateholder, the disk is secured in the latter in such a manner that it can turn freely about its axis. The pressing of a button then releases a pin, to which a reciprocating horizontal movement is imparted by clockwork, and which, engaging successively with the

the entire series of photographs has been made, so that double exposures are prevented.

The lens of the Cinephote is either a "Graphor," which is corrected for astigmatism, and can be used with a stop of F/6 and produces satisfactory outdoor views in most weather conditions, or a "Eurygraph" anastigmat, which is very well corrected for spherical and chromatic aberration and gives perfect definition with a stop of F/3.8. .

As there is no rigid connection between the disk and the mechanism, either single or double plateholders, or even a magazine camera, can be employed.

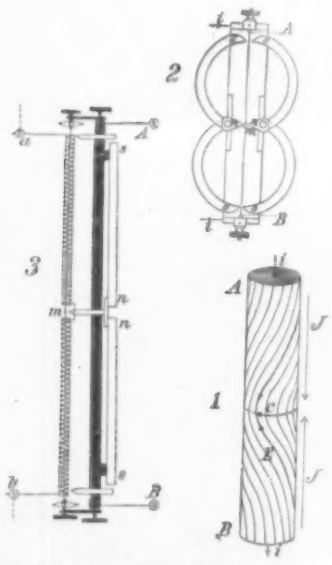
The negatives are developed in the ordinary manner, with the aid of a specially constructed printing frame, and transparent positives are made on disks which have perforations corresponding to those of the negatives. The moving scenes are reproduced and presented to the eye (assisted by a magnifying lens) by means of an automatic mechanism driven by clock-

good. The growth of cast iron under repeated heating is discussed, and reference is made to Outerbridge's work. Steel fittings have also failed; within the author's experience only four out of twenty-five steel gate valves, 6 inches, 8 inches, and 10 inches in diameter, were fairly tight after one year's service. A thoroughly sound steel casting can withstand highly superheated steam, which does not initiate defects, but rapidly develops them. Gun iron is high-grade cast iron having a tensile strength of 30,000 pounds or more, and is adapted for 180 pounds of steam with 300 deg. F. superheat. Analysis of various specimens of iron which failed under 250 deg. superheat are given, but the following successfully withstood 300 deg. superheat for four years: Silicon, 1.72 per cent; sulphur, 0.085 per cent; phosphorus, 0.89 per cent; manganese, 0.48; total carbon, 2.45; combined carbon, 0.17. Low silicon, phosphorus, and carbon character-

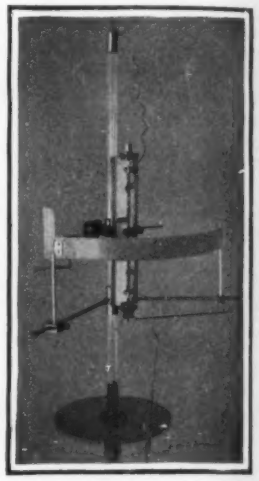
AN INGENIOUS TORSIONAL WAVE DETECTOR

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN

Prof. A. G. Rossi, of the Royal Polytechnic Institute of Turin, has devised a new form of detector for use in wireless telegraphy, which is of special interest because of the novel principle it employs. He uses the property known as "magneto-striction" found in iron or nickel wires. A fine iron wire stretched in a magnetic field is found to lengthen at first, and then shorten, according to the strength of the field, the value effect being about 1-400,000th of the length of the wire. The inventor sought to increase this effect and to apply it to a detector for waves. The principle of the apparatus is shown in Fig. 1. A fine iron wire is stretched in a vertical position between two fixed points *A B*. Two constant magnetic fields formed by two equal bar magnets, magnetize the wire in two halves in the opposite sense with the intensity *J J* and longitudinally, as shown by the arrows. At the same time a current is sent through the wire from *i* to *i*, and this gives a circular magnetization to the wire, with an intensity *c*. The result of the combined magnetic fields will be a magnetization of helical form, *E*. Owing to the effect of magneto-striction, the wire will have a torsion represented at *C* in the direction of the arrow, this being what is known as the Wiedemann torsion effect. Leaving the longitudinal field as it is, if we reverse the current in the wire the torsion effect will be also reversed. When we send an alternating current through the wire we have a strong effect of vibration, as the torsion is also alternating in its sense. A mirror placed at the middle of the wire is made to reflect a beam of light on a screen, and the spread of the beam shows the amplitude of the vibration. The effect is much stronger when the period of the alternating current is of the same value as the normal vibration rate of the wire, and we have a much longer line of light on the screen. The wire is of about 0.02 millimeter diameter, and is held under tension between two light springs mounted on an insulating plate. Fig. 3 shows the arrangement, and the springs are coupled to the binding posts *A B*. Near the ends and at the middle of the wire project three iron points, which come from the bar magnets *n s*, *n s*, so as to guide the magnetic flux into the wire. This latter is stretched inside a glass tube of small diameter, leaving a gap at the center for the mirror *m*. A spiral of insulated copper wire is wrapped about the glass tubes with the two halves coiled inversely and the current comes from *a* and *b* into the wire. The copper spiral is designed to receive the waves from the antenna, and it acts to modify the effect which we have seen above to be given by the combination of the alternating current and the bar magnets in the wire. When no waves are received, we have a constant torsion effect in the wire, that is a constant rate of vibration. When on the contrary the wave effect occurs in the copper spiral, the rate of the vibration is modified, and the line of light on the screen is changed. The terminals *a b* are connected to a pair of vertical antenna wires which are insulated from ground. All the rest of the apparatus is held insulated on a glass tube support 5 feet from the floor. Light for the beam is given by a Nernst lamp, and the same alternating current circuit is used for exciting the wire, using the proper means to secure a very small current through the wire. The copper spiral is joined at the top to the antenna and at the bottom to ground. With such an arrangement, the instrument shows the effect of waves received from a distant station, and we notice variations in the beam of light due to this cause. It is designed especially to be used for receiving signals formed by a succession of waves, such waves to follow each other in series so as to form periods of low frequency. The frequency is first adjusted so as to be the same as that of the vibrating wire. Besides the tuning of the high frequency waves, this allows us to use a second or local tuning of the low period waves. It should be remarked that Prof. Rossi's instrument transforms directly an electric vibration of low frequency into a mechanical vibration, and contrary to other detectors, there is no transformation of energy between the effect of the name and the registered optical indication. It is thus extremely sensitive. To have a permanent record of the signals, the author proposes the use of a photographic band descending in front of the beam, and as the variations of the latter are sidewise, we would have a set of wave-like signals printed on the band. By using a selenium cell, which is lighted by the beam, we could work a Morse register with the instrument, provided a strong enough light is reflected by the mirror on the cell. Owing to the sensitiveness of the instrument, there is no doubt that it can be used with a much less expenditure of power at the sending station. On the other hand it simplifies the apparatus which is needed at the receiving station. An alternating current generator is not required in this case, but a simple vibrator will give the needed impulses for exciting the stretched wire.



How the torsional effect is produced.



A detector which transforms electrical wave trains into mechanical vibrations.

THE HEIGHT OF THE ANTARCTIC CONTINENT

BY WALTER LANGFORD

Our knowledge of the Antarctic continent is daily becoming more precise. Soon after Shackleton's memorable dash toward the South Pole had furnished very important data in regard to the interior of the continent, Charcot's voyage supplied valuable additions to our knowledge of the boundaries of this vast territory. The French expedition succeeded in surveying accurately a great many miles of coast line that had previously been entirely unknown or only conjecturally laid down.

The results of these expeditions prove that the mass of land accumulated about the South Pole is even greater, in comparison with the other continents, than had previously been supposed. The elements involved in this comparison include an estimate of area, and a determination of the heights of the mountain masses. Both of these elements require exact and comprehensive surveys. The problem was first attacked by Humboldt, at an epoch when our knowledge of the earth was very incomplete. Hence Humboldt's estimates of the mean elevations of the known continents above the sea level, are far too low. This mean elevation is the height of a fictitious plateau obtained by distributing the mass of the continent uniformly over its surface, i. e., it is the quotient obtained by dividing the volume by the area. Humboldt's estimates of the mean elevations of continents are: Europe, 672 feet; North America, 748 feet; South America, 1,151 feet; Asia, 1,164 feet; entire known land surface of the globe, 1,004 feet. Except in the case of Europe, these values differ enormously from the more recent estimates given below. This discordance shows the necessity of thorough exploration and accurate surveys, although a general estimate can be obtained from elements of a totally different character, as we shall see in connection with the Antarctic continent. Kruemmel, who was the next after Humboldt to attack the problem, estimated the mean elevation of the entire known land surface of the globe at 1,443 feet, a value which was still far below the truth. The later estimate of Lapparent, based on more complete data, was 2,000 feet, or more, while the more recent estimates of Murray, Penck, Lupan and De Lillo are still higher. Murray's values, as revised by Penck, are: Europe, 918 feet; Australia, 918 feet; North America, 1,968 feet; South America, 2,066 feet; Africa, 2,132 feet; Asia, 3,116 feet; general land surface, 2,312 feet. From these values, which appear to be very nearly correct, the total volume of the continental masses is computed to be about twenty-four million cubic miles.

MEAN HEIGHTS OF THE CONTINENTS.

All of these estimates relate only to those parts of the world that were known at the epochs when the various estimates were made. The recent Antarctic explorations have entirely changed the face of the problem and have raised the Antarctic continent to the first place, which was formerly occupied by Asia. The exact and extensive knowledge which we now possess in regard to the other continents is still lacking in the case of the Antarctic, of which we know only the few points that have been reached by the expeditions.

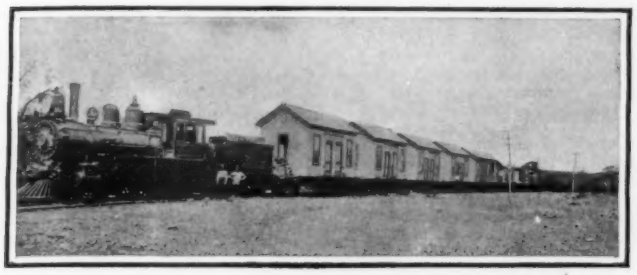
Meinardus has endeavored to determine the height of the Antarctic continent from meteorological data. From the distribution of atmospheric pressures and the exchange of masses of air between the two hemispheres, he

(*Concluded on page 471.*)

CURIOSITIES OF SCIENCE AND INVENTION

MOVING A TOWN BY RAIL.

Pictured herewith is a trainload of houses on the Weatherford, Mineral Wells & Northwestern Railway in Texas. There are five flat cars loaded with miners' cottages of two rooms each, each room being 12 by 14 by 9 feet. Extreme height above the car is 15 feet 4 inches. In addition there are two cars containing the

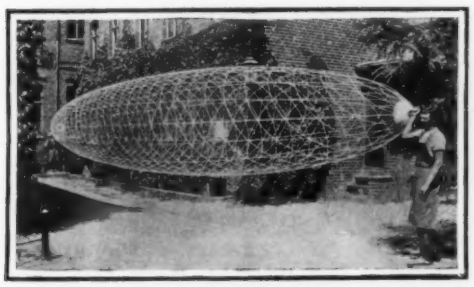


A TRAINLOAD OF MINERS' COTTAGES.

lean-to kitchens, and two cars that carry other wreckage of the coal-mining town of Rock Creek, Texas, whose mines were abandoned. The train was moved successfully at the rate of 15 miles per hour, and around a number of six-degree curves having the outer rail elevated four inches.

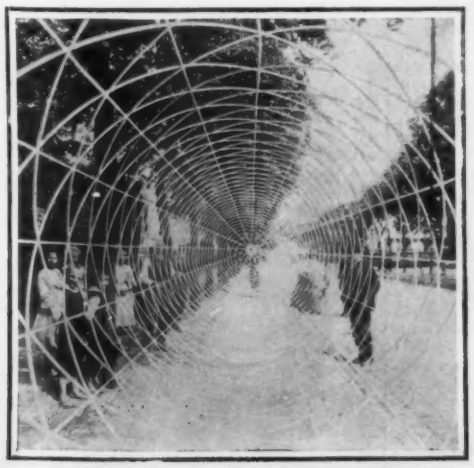
WOODEN FRAMES FOR AIRSHIPS.

When the Zeppelin balloon was destroyed in a thunder storm two years ago it was asserted that a static discharge of electricity from the metallic frame of the balloon had ignited the gas. To obviate such an accident in the future, a German inventor has devised a balloon having a wooden frame, which he claims is



A BALLOON FRAME FORMED OF WOODEN STRIPS.

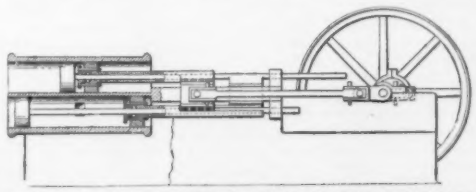
not only lighter than aluminium, but is stronger as well. A frame thus constructed was exhibited at the Frankfort Exposition last summer, and proved quite an attraction. The accompanying photographs show how the frame is made up in a network of wooden strips which is very strong and yet possesses a considerable degree of flexibility. The model illustrated is 65 feet long and 8 feet in diameter. The meshes of the network are much smaller than in the Zeppelin type of balloon, using aluminium framework. Accordingly, the wooden frame makes a more efficient support for the envelope of the balloon when the gas is expanded by the heat of the sun. Another advantage of the wooden frame is the fact that it can be repaired anywhere, whereas aluminium can be worked only with special apparatus and by an experienced workman. The wooden frame is not affected by heat or cold, and may be rendered waterproof by coating it with a suitable varnish.



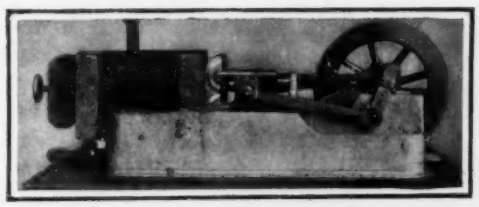
LOOKING ENDWISE INTO THE WOODEN BALLOON FRAME.

ENGINE WITH HEADLESS CYLINDERS.

In order to produce a completely-balanced engine, an inventor has recently adopted the unique plan of providing the engine cylinders with two pistons each. The steam enters between the two pistons, separating them. This renders the cylinder heads useless, for there is no reaction against them. One of the pistons is provided with a hollow piston rod, to receive the rod of the other piston. The engine shaft is provided with two cranks at right angles to each other, which are respectively connected to the two piston rods. Thus a forward and backward impulse is given simultaneously by the steam entering one cylinder, and there is an equal distribution of the load. When the pistons reach the end of their stroke, steam is admitted to a second cylinder of the same type, which repeats the operation while the first cylinder exhausts. There are no jolts, strains or vibrations, as the forces are entirely absorbed in motion. The ends of the cylinders are preferably closed by suitable doors, to prevent dust or other extraneous matter from entering and choking or clogging the working parts. These doors are shown open in the accompanying photograph. The model illustrated has shown remarkably high efficiency, and is so perfectly



SECTIONAL VIEW SHOWING CROSS CONNECTED PISTONS.

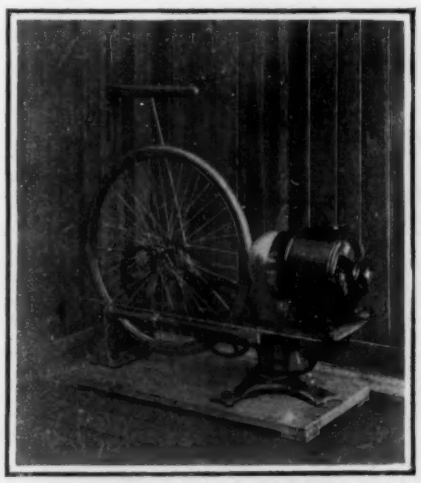


A HEADLESS-CYLINDER BALANCED ENGINE.

balanced that it will run smoothly on the flimsiest of supports.

A NOVEL AUTOMATICALLY ADJUSTABLE ORGAN BLOWER.

A novel method of adapting electric motive power to organ blowing is shown in the accompanying engraving. The mechanism comprises an accurately turned hemisphere of aluminium driven by a small electric motor fixed to a bracket swinging horizon-



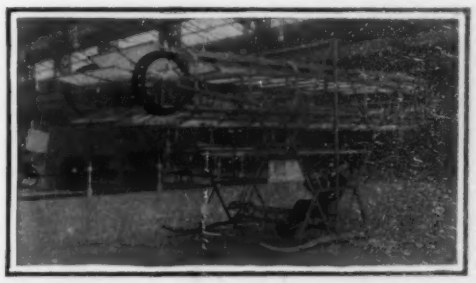
NOVEL ELECTRIC ORGAN BLOWER.

The speed is regulated by a swinging hemispherical friction wheel.

tally on a vertical spindle. The hemisphere drives by friction an ordinary bicycle wheel fitted with a pneumatic tire, as shown in the illustration. There are the usual cycle chain and sprocket gear, for still further reducing the speed, and the final chain wheel transmits reciprocating motion to the bellows handle by means of a crank. There is no slip between aluminium hemisphere and the tire, owing to the elasticity of the air cushion, and as they are constantly in contact there is no wear. This ingenious little machine will blow a 16-stop or larger organ silently and with very high efficiency. It requires no attention, and current sufficient to run the motor is obtained by connection with an electric lamp socket. As it is practically silent and occupies a surface of only 45 by 16 inches, and is 33 inches in height, it can be placed on the floor beside the instrument. The speed of the motor is constant, but automatic control of the pumping is provided by a chain connection between the swinging bracket and organ reservoir or bellows. By means of this chain the motor and hemisphere may be drawn through an arc of 90 degrees into the position of full organ, while a spiral spring returns them to the neutral position, as shown in the illustration. The rising and falling of the reservoir thus cause the speed of the bellows handle to vary from zero to maximum, and keep the bellows full automatically.

A NOVEL PADDLE FLYING MACHINE.

The peculiar flying machine illustrated herewith was one of the novelties at the Olympia Aero Show held recently in London. It is the invention of Messrs. Wyllie and Ottino, and consists of a large number of small planes arranged in an endless band and driven somewhat after the manner of a tread mill, the idea being that as these planes move along from one end of the machine to the other at a rapid rate, they produce



FLYING MACHINE WITH A TRAVELING CHAIN OF LIFTING PLANES.

a lifting effect owing to the slight angle to the horizontal at which they are set. As they move around at one end in passing from the bottom to the top they are at an angle to the horizontal and still produce a lift, while as they descend at the other end their downward movement produces a lifting effect. The machine was exhibited without a motor, but this fact did not detract from its novelty. The idea of the moving planes is that the flying machine will lift itself directly in the air, and that no forward motion over the ground will be required.

A SERPENTINE WHARF.

One of the longest wharves in the world, almost a mile in length, or to be exact, 4,700 feet, is at Port Los Angeles, Cal. It extends into the Pacific in a long serpentine curve. The reason for this construction is that it offers better resistance to the strong currents and the buffetings of the waves than if it were perfectly straight. Until the nearby harbor of San Pedro was developed by the Federal government, the big wharf at Port Los Angeles was a very busy place, but of late it is comparatively seldom used except by the Japanese fishermen, who have formed a colony along the adjacent beach.

A SERPENTINE WHARF NEARLY A MILE IN LENGTH.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

BELT.—G. W. REAM and P. E. GREEN, Butte, Mont. In this case the object of the invention is to provide an extensible belt, which may be folded to form a belt of ordinary width, or unfolded to make a belt of varying capacity, in accordance with the contents to be contained therein, and which in any position will be firmly secured together.

Electrical Devices.

LEVER-CHECK FOR ELECTRIC CONTROLLERS.—J. THOMAS, New York, N. Y. This invention refers to a device to be used as an attachment for controllers such as are mounted on electric cars for controling the operation of the motors. An object is to improve the construction of the pawl so as to render it more efficient. Further, to improve the means for resiliently constraining the pawl arm toward the segment, and to improve the device in other details.

Of Interest to Farmers.

FEEDING ATTACHMENT FOR FANNING-MILLS.—H. DYKSTRA, Spring Valley Township, S. D. The object here is to provide an attachment which can be removably mounted upon the fanning mill, which is adapted to feed fanning mills of different sizes and types, by means of which grain and the like can be fed into the mill continuously and evenly, in which the rate of feeding can be exactly controlled, which is adapted for use with fine as well as with coarse grain, and which is simple to operate.

CLEVIS.—G. H. JOHNSON, Cimarron, New Mex. This invention is an improvement in the construction of the ordinary U-shaped clevis used on plows, cultivators, and harrows for the attachment of draft appliances. The head of the bolt is prevented from contact with other objects, which is very objectionable in clevises of the ordinary construction. In order to protect the head of the fastening device from contact with other objects, it may be arranged in a socket, so that when in locking position, the head does not project above the clevis.

WATERING-TROUGH.—T. C. FEEBOOM, Ireton, Iowa. The aim of the inventer is to provide a simple, strong and durable watering trough, in which the flow of water is automatically regulated, so that the water will not exceed a certain predetermined height in the trough, and in which the flow of the water is positively controlled by the action of the float.

Of General Interest.

GLASS-DRAWING FURNACE.—I. J. RALSTON and J. BRIGGS, Kane, Pa. An object in this instance is to provide a new type of furnace, readily accessible, and which will permit clean and uniform cylinders to be drawn therefrom. Further, to provide a glass-drawing furnace, with means for protecting a plurality of baths therein and with means for framing and protecting a clean drawing surface.

CLOSURE.—C. D. LOVE, Newark, N. J. The purpose of the improvement is to provide a closure for use on bottles and other packages, and arranged to insure perfect hermetic sealing of the package, by the use of a spring interposed between the cap and the closing disk and bearing annularly on the latter at a point opposite to the support for the closing disk.

WRITING-TABLET.—R. C. KUHN, Minneapolis, Minn. Among the principal objects in view in this invention are: to provide an order book having a cover wherein is provided a pocket to contain envelops adapted for mailing the order sheets from which the said book is constructed; and to provide a form of construction which is durable, simple and economical.

ADJUSTABLE RACK REVERSIBLE DEVELOPING-TANK.—P. Y. HOWE, Yonkers, N. Y. The purpose here is to produce a rack for holding the plates within the reversible tank, and to provide a construction for the rack which will enable plates of different sizes to be securely held. The rack involves a construction which permits the plates to descend to the bottom of the tank whether it is held in its upright or in its reverse position.

PASTE-BOX.—O. DREHER, Stroudsburg, Pa. The purpose of the inventor is to so construct the brush holder that the brush will be automatically raised from a substantially horizontal position to an inclined position, as the cover of the box is raised. This brings the handle of the brush to an elevated position above the top of the box, so that it may be readily grasped ready for use.

DISPLAY APPARATUS.—E. F. CANNON, Portland, Ore. The object here is to provide an apparatus for exhibiting goods or wares, in which the goods are arranged upon carriages which travel successively and continuously in a plurality of directions and thus show the goods to the best advantage and from different sides, and in which the carriages are movably supported upon the floor, which, at the same time, serves to conceal the mechanism for actuating the carriages.

ANIMAL-TRAP.—P. J. KOTTUM, Sacred Heart, Minn. This trap is of the class that chokes the captured animal to death, and the object is to provide a trap of this character, that is simple, strong, easy to produce, and which, when assembled presents a compact crap that is very effective and kills the animal without injuring its pelt.

Household Utilities.

STAND-BOILER.—W. SHERWOOD, New York, N. Y. The object of the invention is to provide a boiler, arranged to direct the hot water coming from the heater or water back of the range or furnace, into the top of the boiler, to prevent this hot water from being reduced in temperature by contact with the cold water entering the boiler shell from the water main or other supply at or near the lower end of the boiler shell.

CLOTHES-LINE HOLDER.—A. HEINZINGER, New York, N. Y. The invention relates to holders of the kind especially adapted for use in connection with buildings, the more particular purpose being to provide a holder having an arm mounted upon a window jam, or the like, and adapted to swing for the purpose of affecting the condition of the clothes-line which is practically supported by the arm.

ELECTRIC COOK-STOVE.—F. H. ZEIGEN, Detroit, Mich. This cooker is more or less analogous to a so-called "fireless cooker," and the aim is to fit within the same a number of electrically-operated heating units for supplying heat to the stove. Heat is regulated by a proper distribution of the heating units, by cutting out a suitable amount of the resistance offered by the heating units themselves.

CHAIR.—W. S. PHILLIPS, Cameron, W. Va. The invention is an improvement in chairs, and the object of the improvement is to provide a chair, which will fold up under a table or other support out of the way, when not in use, by means of a spring and which may be easily drawn out into position when required, and will be locked in such position by its own weight.

Machines and Mechanical Devices.

LOOSE-LEAF BINDER.—T. BRAZIL-DINEEN, North Sydney, New South Wales, Australia. The object of the inventor is to provide a mechanism for the binding plates, which is arranged so as not to diminish the capacity of the case or frame or be injured when the clamping plates are fully moved apart, and which extends longitudinally of the case to one end thereof at a point conveniently accessible for operation.

TIPPING FURNACE, MIXER, ETC.—J. L. KLINDWORTH, Bellevue, Pa. The improvement is designed to provide means of an efficient character for protecting the actuating screw from contact with dirt, molten metal, or other foreign matter, and further, to provide means of novel character for relieving the actuating screw and nut from vertical and lateral thrust and pressure.

AIRSHIP.—L. ARNHEITER, Jersey City, N. J. The object of the inventor is to provide an airship or aeronef, arranged to provide a large sustaining surface, and to permit of conveniently raising, lowering, propelling and steering the ship in any desired direction. The suspended car is preferably in the form of a boat capable of floating on the water if required, and to allow the aerial vessel to again rise from the water.

Prime Movers and Their Accessories.

CARBURETER.—G. E. COOK, New York, N. Y. One object in this case is to provide means whereby the opening of the throttle valve to bring an increased number of jets into operation, also operates to permit of an automatic dilution of the explosive charge in accordance with the suction pressure and speed of the engine.

ELASTIC-FLUID MOTOR.—J. I. SHIRLEY, 2a Bucarelli, No. 809, City of Mexico, Mexico. This invention consists in an elastic-fluid motor having a rotating distributing valve which is adapted by its rotation to supply working fluid to one or more cylinders and exhaust the working fluid therefrom in the proper sequence. It further consists in the improved distributing valve and valve gear.

Railways and Their Accessories.

STAND-PIPE FOR RAILWAY WATER-SUPPLY.—P. H. KNIGHT, St. Joseph, Mo. The principal objects here are: to provide a construction of a pipe wherein the operative parts are constructed in a form light, strong and durable; to provide a construction wherein the usual splashing or loss of water incident to the operation of drawing same at the water stations is eliminated; to provide an operating mechanism which is compact, certain and easy of manipulation; and to provide a construction adapted to compensate the disadjustment incident to employment in the ordinary service.

Pertaining to Vehicles.

CAR-FENDER.—C. P. BRONSON, Corning, New York. The invention is an improvement in fenders, more especially designed for automobiles, and has in view a comparatively light fender, which when in normal position, is compactly arranged and projects a relatively small distance beyond the front of the vehicle, and when striking a body, is automatically forwardly extended to receive and support the object struck.

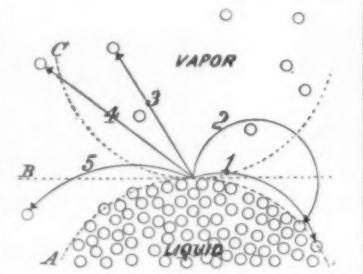
NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Notes and Queries.

Kindly write queries on separate sheets when writing about other matters, such as patents, subscriptions, books, etc. This will facilitate answering your questions. Be sure and give full name and address on every sheet.

Full hints to correspondents were printed at the head of this column in the issue of March 13th, 1909, or will be sent by mail on request.

(12240) J. F. B. writes: In your issue of April 16th C. F. L. inquires for an explanation of the connection between curvature of surface and vapor pressure. The following is abbreviated from Millikan's "Mechanics Molecular Physics and Heat," price $1.65, and Watson's "Physics," price $3.50, together with a few wrinkles of my own. All matter is conceived by physicists to be composed of molecules whose shape is not definitely known. One of the most characteristic differences between a liquid and its vapor is that the molecules are close together in the liquid and farther apart in the vapor, somewhat as suggested by the diagram. A very essential part of this molecular theory is that the molecules are in motion; and because there is no friction between them, their motion does not die down because of collisions, merely rebounding according to the laws of perfectly elastic impact. Hence a drop of water has more of an exact boundary than a pile of sand or marbles if reduced to corresponding dimensions. A mathematical treatment will show that the foregoing hypotheses lead to another, namely, that the molecules could not all have the same velocity even though initially endowed with the same velocity. Whence we come to the conclusion that molecules are continually arriving at the surface of the drop with varying speeds and directions. Some molecules will have such low speeds or such unfortunate directions that they will be attracted back into the liquid. Such are represented by 1 and 2. Others, as for example No. 3, will have such high velocities as to be able to escape against the attraction of the molecules remaining in the liquid. These molecules which escape become a part of the vapor. The attraction which tends to prevent the escape and actually retards it, is otherwise called



cohesion, though merely gravitation at close range. Now let us consider the liquid at the different curvatures, as *A*, *B*, and *C*. Molecules 1 and 2 would return to the liquid in any one of the three cases, while molecule 3 would probably escape at the same time. Molecule 4 however would return to the liquid if the surface were at *C*, but would escape if it were at *A* or *B*, and molecule 5 would escape if the surface were at *A* but would return to the liquid if the surface were flat or concave. Therefore we feel at liberty to make the following statements: (1) That more molecules can escape per second from a convex surface than from a flat one, and (2) more from a flat one than from one that is concave. Since the vapor pressure at a given temperature for a given liquid depends on the number of molecules that can leave per second, we see that the vapor pressure of a convex liquid surface is greater than one that is flat or concave, and that the more convex the greater the vapor pressure. These conclusions have an interesting connection in the formation of rain. The microscopic drops constituting the clouds are not in all probability all of the same size, so that the small ones would have a tendency to evaporate and the vapor condense on the larger ones with a much weaker vapor pressure. Thus the drops grow until large enough to fall rapidly. After falling becomes quite rapid it is probable that collision with smaller drops is more efficient in increasing their size.

(12241) B. L. C. asks: Does air or other gas expand when heated in a closed cylinder sufficiently for the pressure to be increased, and if not, how is the pressure increased? A. Air cannot expand in a closed cylinder, if heated. The pressure rises because of the increase of heat energy which would cause expansion if the air were under only normal pressure and were heated. All gases act nearly alike in this respect. The expansion for a rise of temperature from 0 deg. C. to 1 deg. C. is 1/273, and so on for higher temperatures. Kent in his "Mechanical Engineer's Pocket Book" gives a table of pressures and temperatures up to 200 pounds pressure. At 200 pounds pressure the temperature of air not cooled is 672 deg. F.

NEW BOOKS, ETC.

THE ADVANCEMENT OF INDUSTRY. BEING A STUDY OF CERTAIN MANUFACTURING INDUSTRIES IN INDIA, WITH SUGGESTIONS FOR THEIR DEVELOPMENT. By Henry Hemantakumar Ghosh. Calcutta, India: R. Cambray & Co., 1910. 8vo.; 222 pp.

The early years of the present century have witnessed the birth of a new era in India, which is likely to be remembered as much for the industrial awakening it has caused, as for the political aspirations it has aroused in the people. The author attempts to make some suggestions for the improvement of native industries. The illustrations are awful; we have almost never seen such cuts in any printed book. It is not likely that the book will be of much interest to American readers.

SOLID BITUMENS. Their Physical and Chemical Properties and Chemical Analysis. Together with a Treatise on the Chemical Technology of Bituminous Pavements. By S. F. Peckham, A.M. New York and Chicago: Myron C. Clark Publishing Company, 1909. 8vo.; 324 pp. Price, $5.

The literature of bitumens is rather limited, therefore the present volume will prove of value. The titles of the chapters are as follows: Geographical Distribution of Bitumens; Origin of Bitumens; The Classification of Bituminous Substances; The Derivation of Natural Solid Bitumens; The Derivation of Bituminous Rocks; The Derivation of Artificial Solid Bitumens; General Considerations Concerning the Chemistry of Solid Bitumens; Boussingault's Memoir Upon the Composition of Bitumens; The Use of the Words, Petrolene, Asphaltene, etc.; The Ultimate Analysis of Solid Bitumens; The Proximate Analysis of Solid Bitumens; The Technical Analysis of Solid Bitumens; Special Chemical and Physical Methods of Analysis by Which Solid Bitumens May be Recognized and Distinguished; Miscellaneous Methods Applied to Street Mixtures and Surfaces. Bituminous Paving Blocks, Bituminous Concrete, Wood Paving Blocks, Cements, Cement Mortars and Concrete, etc.; Specific Gravity, etc.; Historical Introduction; A Modern Street; Bitulithic Streets; The Oiled Roads and Streets of the Pacific Coast; Asphalt Blocks; Wood Blocks; Conclusions.

PATTERN MAKING. By H. Willard. Chicago: Popular Mechanics Company, 1910. 12mo.; 214 pp. Price, $1.

This book contains chapters on core making and molding. It is written by a practical pattern maker of long years' experience. The information given appears to be of a very practical nature, and the book will undoubtedly prove of value.

PRACTICE AND THEORY OF THE INJECTOR. By Strickland L. Kneass, C.E. New York: John Wiley & Sons, 1910. 8vo.; 175 pp. Price, $1.50.

Since the publication of the second edition, there have been marked changes in the construction of locomotives which have reacted upon the method of feeding boilers and consequently upon injector design. Many of the heavy articulated types have no available space within the cab for an injector of the required capacity, so that the trend is again toward the non-lifting form. Further, motive power officials are recognizing the advantage of utilizing waste products for heating the feed water, and purifying it of scale-bearing salts, and are giving more attention to the details of boiler feeding accessories which make for economy of operation as well as for the safety of passenger and employee. Owing to the development of the steam turbine, a large amount of experimental work has appeared in technical journals in connection with the flow of steam. It is gratifying to the author that these late investigators confirm his experimental work, first published in 1891, extracts from which are given in the text.

MOSQUITO OR MAN; THE CONQUEST OF THE TROPICAL WORLD. By Sir Rupert W. Boyce, M.B., F.R.S. New York: E. P. Dutton & Co., 1909. 8vo.; 267 pp. Price, $3.50 net.

The author has purposely selected the title "Mosquito or Man" in his endeavor to epitomize in one the tropical-medical movement which is now spreading all over the civilized world. Large numbers of well-equipped medical men have been sent to the tropics. Vast mines of literature dealing with tropical diseases have been distributed, and the public has been steadily educated to understand that it is not impossible to make the tropics healthy. The author shows that the three great diseases of the tropics which were the greatest enemies that mankind has ever had to contend with, namely, malaria, yellow fever, and the sleeping sickness, are now fully in hand. The tropical world is unfolding once more to those who do not now dread the unseen hand of death as did the men of old. The book is admirably printed and is beautifully illustrated.

THE COPPER HANDBOOK. A Manual of the Copper Industry of the World. By Horace J. Stevens. Houghton, Mich., 1909. 8vo.; 1,628 pp.

The book before us is almost appalling with its vast array of facts as to the various cop-

per properties of the world. The copper mines in various countries are dealt with, and there is an excellent glossary. There are also chapters on the uses of copper; substitutes for copper; brands and grades of copper; alloys of copper; electro-metallurgy of copper; pyro-metallurgy of copper; hydro-metallurgy of copper; milling and concentrating of copper; mining of copper; chemistry and mineralogy of copper, geology of copper, etc.

AMERICAN GAS PRODUCER PRACTICE AND INDUSTRIAL GAS ENGINEERING. By Nisbet Latta. New York: D. Van Nostrand Company, 1910. 4to.; 439 pp. Price, $6 net.

Producer gas is gaining in favor each year in the United States, and it will take some time before there is an adequate literature relating to it. The present volume goes a long way toward filling a vacant niche. The author is thoroughly acquainted with his subject, as is shown by the handsome piece of book-making before us. The chapters deal with Producer Operation; Cleaning the Gas; Works Details; Producer Types; Moving Gases; Solid Fuels; Physical Properties of Gases; Chemical Properties of Gases; Gas Analysis; Gas Power; Gas Engines; Industrial Gas Applications; Furnaces and Kilns; Burning Lime and Cement; Pre-Heating Air; Doherty Combustion Economizer; Combustion in Furnaces; Heat; Temperature, Radiation and Conduction, etc. The book has 247 illustrations.

PRACTICAL DYNAMO BUILDING FOR AMATEURS. By Arthur J. Weed. New York: Norman W. Henley Publishing Company, 1910. 12mo.; 83 pp.; 64 illustrations. Price, $1 in cloth; 50 cents in paper.

Practical directions are given in this work for the construction of a small dynamo of the type particularly adapted for use in manual training schools and State colleges. The dynamo has a capacity of 50 watts, and weighs but a little over five pounds, so that it is of convenient size for use in a class room or in a lecture hall, where it can be passed around for purposes of illustration. This little machine has been successfully used for furnishing current to spark coils. In a large New England wire mill a dozen of these machines have been used as motors for spooling fine copper wire.

THE BOY AVIATORS IN NICARAGUA. By Captain Wilbur Lawton. New York: Hurst & Co., 1910. 12mo.; 336 pp. Price, 35 cents.

This book is nothing if not up-to-date. It takes up a most exciting story of a most impossible nature, in which two boys who have built an aeroplane become involved in the revolution of Nicaragua. Their exciting adventures with a general of the Nicaraguan forces who is bent on their destruction, and also that of a newspaper correspondent, should give boy readers many a thrill.

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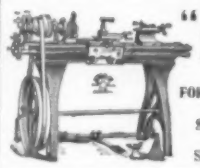

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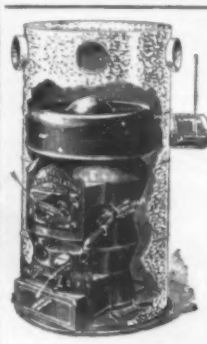

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(*Concluded from page 456.*)

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He assumes the case of a modern battleship, with 36,000 horse-power developed on three screws, the outer screws driven by turbines of 15,000 horse-power, and 140 pounds initial pressure, the center screw being driven by a Herrick rotary engine of 280 pounds absolute pressure, and a superheat of from 100 to 200 degrees. Assuming a water rate of 13 pounds for the turbines, Mr. Lovekin arrives at his ultimate water rate of 10.8 pounds for the combination as follows:

The revolutions of the turbines will be 275 per minute.

The revolutions of the rotary engine will be 160 per minute.

The effective stroke of the rotary engine will be 17 feet.

The clearance will be 12 per cent.

The stroke, plus the clearance, will be equal to 19 feet.

The distance swept by the piston per hour, allowing for clearance, will be $19 \times 160 \times 60 = 182{,}400$ feet.

The total cubic feet of steam used will be $390{,}000 \times 3.2 = 1{,}248{,}000$.

The area of the piston will be

$$\frac{1{,}248{,}000}{182{,}400} = 6.85 \text{ square feet.}$$

Assume pistons 16 inches high,

$$\frac{6.85 \times 144}{16 \times 3} = 20\tfrac{1}{2} \text{ inches,}$$

width of each piston. (3 in all.)

The horse-power developed by the rotary engine is as follows:

2 expansions = 0.8465

280 × 0.8465 = 237 pounds.

140 pounds back pressure.

97 pounds.

0.80 ratio of actual mean to theoretical pressure.

77.60 (Approximate.)

$$\frac{78 \times 17 \times 6.85 \times 144 \times 160}{33{,}000} = 6{,}380 \text{ H. P.}$$

for rotary engine.

Assuming 6,000 B. H. P., with a propeller efficiency of 60 per cent.

The turbines will give out 30,000 B. H. P. at 50 per cent.

The rotary will give out 6,000 B. H. P. at 60 per cent.

Total ..... 36,000 B. H. P.

$$\frac{390{,}000}{36{,}000} = 10.8 \text{ pounds of water per B. H. P.}$$

RADIUM BATHS.

(*Continued from page 461.*)

ried into practice on a large scale by the Administration of the Municipal Salines of Kreuznach, Germany, where drinking and bathing water, artificially treated by the very radioactive substances contained in the springs, is manufactured and sold.

Though details of the process used in this connection are as yet kept secret, we are enabled by the courtesy of the administration mentioned, to place before our readers a general account of the methods by which brine is prepared and treated for radioactive substances, which in their turn are used to energize ordinary cistern water or to increase the efficiency of any therapeutic product.

The Kreuznach brine, which contains besides other elements iodine and bromine, yields, after boiling, 45 liters of mother liquor of a specific gravity of 1.3, per 100 kilogrammes salt. Because of the large amount of water which must be evaporated in obtaining the salt and

(*Continued on page 469.*)

(Concluded from page 468.)

Talking machine and piano recording device, W. M. Davis 958,730
Talking machine mechanism, C. Lindstrom 959,238
Telegraphy, aerial conductor arrangement for wireless, G. von Arco 959,100
Telephone call mechanism, party line, W. E. Zabst 958,847
Telephone receiver bracket, H. P. Voss... 959,469
Telephone set, W. Kaisling 958,925
Telephone standard, desk, C. T. Mason ... 959,243
Telephone switch hook, B. W. Sweet 958,979
Telephone system, W. W. Dean 959,856
Telephone system, Gradolph & Hahne..... 958,868
Telephone system, party line, H. J. Roberts 958,894
Telephone systems, party line call register for automatic, A. H. Dyson 958,863
Telescope, A. Swasey 959,179
Telescopic tube, O. Mackensen 958,732
Textile conditioning apparatus, I. E. Palmer 959,067
Thawing tool, steam, G. H. Finnegan 958,737
Thread guide, I. E. Palmer 958,700
Threshing machine band cutter and feeder, McReynolds & Graham 959,432
Threshing machine, seed, D. Hummel..... 959,346
Tie. See bundle or package tie.
Tile marker, W. H. Starr 959,260
Tilting chair, J. Flindall 958,908
Timer and distributor, C. Cuno 958,908
Tire, A. Kessler, Jr. 959,353
Tire case, C. A. Russell 959,391
Tire, vehicle, J. Allend 959,041
Tires, cap for valve stems for pneumatic, G. F. Foss 959,867
Tires, external armor for pneumatic, J. L. La Driere 958,748
Tobacco stemming machine, J. O. Morris.. 959,375
Tongs, clothes, W. J. & A. Gift 958,938
Tongue hounds, adjustable pattern for, N. J. Smith 959,358
Tool, N. M. Hansen 958,807
Tool holder, J. J. McIntyre 958,936
Tool holder, J. T. Stoffer 958,945
Tool holder, ratchet, J. Volbert 959,408
Tooth crown, P. Schaefer 959,395
Tooth, replaceable, F. La Chapelle 959,358
Torpedo, E. Bourdelles 958,990
Toy, W. S. Hendron 959,009
Toy base ball game apparatus, J. A. Ekelund 959,427
Traction engine, L. M. Merkley 958,816
Trestle, builder's, O. Knoerzer 959,228
Trigger mechanism, E. R. Williams 959,413
Trocar, self cleaning, O. L. Bunn 958,854
Trolley and box, aerial mail, T. G., S. C. & E. G. Anderson 959,418
Trolley conductor clamp, W. Schnake 958,833
Trolley poles and other articles, clamp for mending broken, R. W. Lovett 958,751
Trolley wheel holder and guide, Gunn & Link 958,744
Trolley wire car, J. H. Callender 958,906
Trolley wire hanger, J. T. Scanlon 959,076
Trombone, S. J. Sumners 959,034
Trombones, slide bearing for, S. J. Summers 959,033
Trousers band regulator and belt retainer, combination, J. E. Well 959,086
Trousers hanger, W. C. Thatcher 959,181
Trousers rack, T. A. Cleary 959,112
Truck brake, baggage, Parker & Lich 959,251
Truck for planters, etc., front, I. D. Brim.. 959,302
Truck, maximum traction, W. S. Adams.... 959,040
Tube. See telescopic tube.
Tug, buggy shaft, W. G. Petree..... 959,254
Tunneling machine, G. R. Bennett 958,952
Type casting and setting machine, individual, J. C. Fowler 958,738
Type machines, mold and operating mechanism for, E. S. Dunavant 959,323
Typewriter attachment, T. M. Morgan.... 959,024
Typewriters, column stop mechanism for, Knapp & Harting 959,061
Typewriting machine, A. W. Smith 958,778
Typewriting machine, J. C. McLaughlin, 958,817, 958,818
Typewriting machine, J. A. Edlund 959,125
Umbrella, W. Edwards 959,127
Umbrella, folding, O. K. Andrews 958,714
Umbrella, folding, P. Perzene 959,383
Umbrella holder, S. A. Reithmiller 959,072
Underclothing, C. M. Begley 959,196
Universal joint, A. H. Fetzer 959,129
Upsetting machine, D. R. Ward 959,184
Valve, G. M. Bard 958,716
Valve, E. D. Jefferson 959,349
Valve, automatic hose, L. E. & W. Smith. 958,779
Valve for air brake systems, regulating, J. C. Luna 959,022
Valve for heat engines, puppet, L. G. Nilson 958,759
Valve mechanism for engines, J. W. Guthrie 959,339
Valve, relay air, H. J. Richardson 959,073
Valve, steam, air, and water trap, J. E. Boegeh 959,297
Valve timer, gas engine, T. P. Huden 959,345
Vapor burner, A. H. Waite 959,410
Vault closure, F. Unekrich 959,406
Vegetable washer, E. J. Judge 958,812
Vehicle body structure, E. H. Remde 958,910
Vehicle body structures, fastening device for, E. Gruenfeldt 958,917
Vehicle brake, automatic, G. W. Whitcomb 959,279
Vehicle, child's, C. E. Fourman 958,914
Vehicle controlling mechanism, motor, L. Whitcomb 959,087
Vehicle propelling mechanism, motor, Lacoste & Battmann 959,231
Vehicle rim, A. A. Ley 959,236
Vehicle shock absorber, Riley & Hunt 959,170
Vehicle, single track, R. E. Scheri 959,077
Vehicle spring, C. B. Geiger 959,336
Vending machine, C. Manshel 959,063
Vessel, submarine, A. J. Griffin 958,742
Violin bow, F. Della Torre 958,784
Vise, door fitting, C. E. Rose 959,264
Volume regulator and indicator, F. L. Cross 958,726
Wagon jack, S. L. Porn 959,255
Wagon seat fastener, L. M. Lattimore..... 959,361
Washer. See dish washer.
Washer and gasket cutter, J. A. Rose.... 958,941
Washing machines and other containers, hasp handle for, J. P. Holtzhouser 958,745
Watch and clock center friction, F. Wehinger 958,987
Watch, repeating, H. M. & O. Reiner.... 959,165
Water heater and purifier, H. White,..... 958,845
Water heater, electrical, H. D. Wood, Jr.. 958,846
Water purifier, centrifugal, W. K. Richardson 958,770
Water, purifying and sterilizing, A. Baudry 958,848
Water, purifying or clarifying, W. K. Richardson 958,769
Water softening apparatus, H. Russell, 958,831, 958,832
Water wheel gates, apparatus for operating, W. W. White 959,280
Waterproof fabric, G. Great 959,178
Wave power, S. B. Goff 959,214
Weaving pile fabrics, J. Buckler 959,306
Welding machine, electric, A. E. Buchenberg 959,305
Well tools, etc., joint for, C. M. Heeter.. 959,341
Well tubes, unscrewing mechanism for, H. G. Johnston 959,351
Welt beveling machine, W. B. Keighley 959,223
Wheel, J. L. Jackson 959,058
Wheel guard, J. M. Yount 958,791
Wind shield, E. J. Montigny 959,374
Window, reversible, D. E. Hipolito 958,902
Wire fabric making machine, W. N. Parrish 958,888
Wrench, F. Schneider 959,029
Wrench, W. Ducharme 959,322
Wrench structure, C. B. Grim 959,056

A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since 1863, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway, New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., Inc., 361 Broadway, New York.

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Concrete Pottery and Garden Furniture

By RALPH C. DAVISON

Assistant Secretary Concrete Association of America

12mo 196 Pages. 140 Illustrations.
Price $1.50 postpaid.

THIS work should appeal strongly to all those interested in ornamental concrete, as the author has taken up and explained in detail in a most practical manner the various methods of casting concrete in ornamental shapes. The titles of the thirteen chapters which this book contains will give a general idea of the broad character of the work. They are entitled:

I, Making Wire Forms and Frames; II, Covering the Wire Frames and Modeling the Cement Mortar into Form; III, Plaster Molds for Simple Forms; IV, Plaster Molds for Objects Having Curved Outlines; V, Combination of Casting and Modeling—An Egyptian Vase; VI, Glue Molds; VII, Colored Cements and Methods Used for Producing Designs with Same; VIII, Selection of Aggregates; IX, Wooden Molds—Ornamental Flower Pots Modeled by Hand and Inlaid With Colored Tile; X, Concrete Pedestals; XI, Concrete Benches; XII, Concrete Fences; XIII, Miscellaneous, Including Tools, Waterproofing, and reinforcing.

The first two chapters explain a most unique and original method of working pottery which has been developed by the author. The chapter on color work alone is worth many times the cost of the book inasmuch as there is little known on this subject, and there is a large and growing demand for this class of work. The author has taken for granted that the reader knows nothing whatever about the material and has explained each progressive step in the various operations throughout in detail. These directions have been supplemented with half-tones and line illustrations which are so clear that no one can misunderstand them. The amateur craftsman who has been working in clay will especially appreciate the adaptability of concrete for pottery work, inasmuch as it is a cold process throughout, thus doing away with the necessity of kiln firing, which is necessary with the former material. The book is well gotten up, and is printed on heavy glazed paper and abounds in handsome illustrations throughout, which clearly show the unlimited possibilities of ornamentation in concrete.

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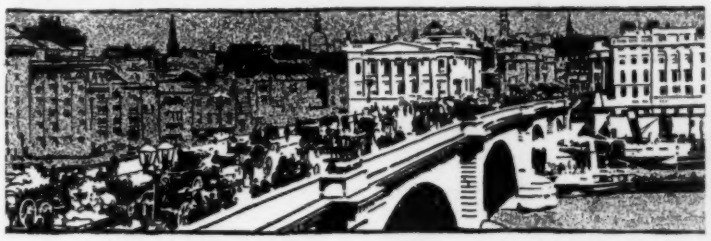

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NEW YORK, 153-157 Fifth Avenue Temple House, Temple Avenue, LONDON

(Continued from page 468.)

the mother liquor, this process is very complicated and expensive.

The brine is vaporized in graduating works, the output of which depends on the season, the direction and intensity of winds, as well as on the temperature and moisture of the air. Each of these graduating works (the total length of each is approximately 2.5 kilometers) is divided into seven compartments of decreasing lengths, traversed consecutively by the brine, and the salt content increasing as each compartment is traversed. After leaving the last compartment the weak solution is from eight to twelve times more concentrated. The bramble walls of the compartments are exposed to the wind. Hence operation of the plant is difficult in variable winds. On the other hand, the surrounding air, which is strongly ozonized and charged with atomized brine, not only makes the graduating works a very cool and pleasant place to stay in on hot days, but affords a welcome opportunity for utilizing the curative effects of the refreshing salt air.

The pumps of the graduating works are operated by a number of water wheels fed from the river Nahe through a system of canals. From the graduating works the brine is pumped through conduits to the reservoirs of the evaporating house, in order there to be boiled.

Both the evaporating house and graduating works date from the middle of the eighteenth century when the Salines were erected, the ancestors of most of the workmen employed therein having spent their lives in the works.

The primitive boiling process carried out in open salt pans has recently given way to a modern multiple vaporizer with improved devices for recovering the mother liquor and the salt. It consists of a steam boiler and a number of vaporizers, an air pump, etc.

As the boiling of the brine and mother liquor is carried out *in vacuo* at low temperature, the decomposition of valuable chemical compounds is entirely prevented, thus increasing the curative effects of the products.

When the brine has been boiled down to such concentration as to contain in a hundred kilogrammes, twenty-two kilogrammes of common salt, a supersaturated solution is obtained from which the salt crystallizes. As the concentration of the brine increases, then increasing amounts of salts are separated, which impart to the salts an acid taste. These salts are used for various therapeutic purposes, while the brine left after the separation of the common salt forms the mother liquor used for other therapeutic purposes, and of which about 350,000 liters are produced per annum. For shipping great distances, the mother liquor is further concentrated, until it crystallizes in lumps.

Experiments commenced in 1904 have shown that the Kreuznach water contains not only plentiful amounts of gaseous radioactive emanation, but carries along from the interior of the earth radioactive substances. Part of these substances, as the water during the graduating process comes into contact with the air, will separate along with iron oxide, calcium and barium carbonate, while another part remaining in solution forms in the brine a permanent source of emanation. Experiments made by Elster and Geitel, as well as by Dr. K. Aschoff, have shown that the residues contain not only considerable traces of radium, but radiothorium and actinium as well. The mother liquor derived from the Kreuznach brine as well as from the bathing salt was likewise found to be strongly radioactive. Further experiments demonstrated the possibility of isolating traces of radium from the residues of concentrating the radium salts. As the springs of Kreuznach yield every year radioactive residues by the hundredweight, it was deemed advisable to attempt the production of radium salts on a large scale. Mr.

(Concluded on page 470.)

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Advertising in this column is 75 cents a line. No less than four nor more than 10 lines accepted. Count seven words to the line. All orders must be accompanied by a remittance. Further information sent on request.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. There is no charge for this service. **In every case it is necessary to give the number of the inquiry.** Where manufacturers do not respond promptly the inquiry may be repeated.

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100 PER CENT. profit selling the Lindsay soft inverted mantles: fit any inverted gasoline light. Steady customers in every town. Fine side line for salesmen. Vest pocket samples and prices on request. Lindsay Light Co., Dept. B, Chicago.

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FOR SALE.—Interest or control in manufacturing business. Exceptional opportunity for manager or instrument maker. Control, Box 775, N. Y.

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WE are about to complete a large contract for Taximeters and are therefore in a position to take up experimental work, manufacture of fine instruments, parts for the same, dies, jigs, etc. Precision Tool & Instrument Co., 3-15 Canal Place, New York City.

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Inquiry No. 9121.—Wanted, manufacturers of cut stencils for fancy work, sofa pillows, etc., and oil colors and brushes for same.

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Inquiry No. 9127.—Wanted, address of L. Dermigny, manufacturer of a family ice machine for $10.00

Inquiry No. 9132.—Wanted, manufacturers of a gasoline traction engine with a hoisting attachment; in other words, the machine will be used as a portable stump puller to pull sassafras roots, used in making oil of sassafras.

Inquiry No. 9134.—Wanted, a small hydraulic motor, capable of giving about one horse power with a water power of 35 lbs. per square inch.

Inquiry No. 9135.—Wanted, name and address of manufacturers of the Parshall Compressed Air Ice Machine.

Inquiry No. 9136.—Wanted, the name and address of a skunk raising farm.

Inquiry No. 9137.—Wanted, a device that will braid leather strips for horse whips.

Inquiry No. 9138.—Wanted, the address of manufacturers of machines capable of forming a number (12 or more) of pieces of paste about 36 mm. x 32 mm. x 6 mm., made of lead oxide and sulphuric acid, and placing them into a frame having a separate compartment for each piece, the space between each piece and the next being all round 4 mm. The process could be somewhat similar to biscuit making.

Inquiry No. 9139.—Wanted, the name and address of some manufacturer of a coffee mill run by water motor.

Inquiry No. 9140.—Wanted, manufacturers of disc records for gramaphones that use a sapphire point instead of a steel needle.

Inquiry No. 9143.—Wanted, name and address of the manufacturers of an air mattress.

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Inquiry No. 9145. Wanted, to buy machinery to load blasting caps or detonators.

Inquiry No. 9149.—Wanted, manufacturers of machinery for roasting coffee for small and large industries.

Inquiry No. 9150.—Wanted, manufacturers of machinery for the manufacture of French heels for ladies' shoes.

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Inquiry No. 9153.—Wanted, name and address of manufacturers of a knotless clothes line.

Inquiry No 9154.—Wanted, name and manufacturers of a newspaper vending machine.

Inquiry No. 9155.—Wanted, the address of manufacturers of an electric milking machine.

Inquiry No. 9156.—Wanted, the name and address of manufacturers of a rust proof oil, known as Cachoue Oil.

Inquiry No. 9157.—Wanted, manufacturers of peanut shelling and cleaning machinery.

Inquiry No. 9158.—Wanted, manufacturers of a material in sheets to take the place of vulcanized fibre for novelty work.

Inquiry No. 9159.—Wanted, manufacturers of any successful substitute for hard rubber.

Inquiry No. 9161.—Wanted, a machine that will grind oranges, pulp and skin into a smooth liquid or cream.

Inquiry No. 9162.—Wanted, addresses of shirt makers in Manhattan, who will make a few shirts of special design.

Inquiry No. 9163.—Wanted, manufacturers of a cradle worked by clock work.

Neumann, Director of the Kreuznach Salines, undertook experiments according to a method worked out by Dr. Aschoff. One of the wings of the boiling house was converted into a radium factory, which has been operated for over a year. The entire annual production of active residues is now worked into radium salts, an end which has made possible an extensive therapeutical use of radium compounds, both as a white insoluble powder of high radioactivity for compresses, ointments, etc., or directly in a dried condition, and—on a far larger scale—in the shape of gaseous emanation transmitted to water.

An apparatus perfected by Mr. Neumann renders it possible to determine the amount of emanation imparted to a given quantity of water.

Mr. Neumann has recently worked out an improved charging method which is especially suited for imparting to any liquids a very intense activity (2,000 to 50,000 Mache units). However, no details as to this method have as yet been made known.

Satisfactory results have been obtained by treating, by means of charged drinking or bathing water, chronic rheumatism of the joints, and gout, while a number of other complaints are favorably acted upon.

An interesting fact ascertained by those physicians who have tried the radium-water treatment, is that many patients at the beginning of the cure will show a striking reaction, consisting of a recrudescence of some symptoms of the malady, and in some cases in some trouble in the general condition (insomnia, loss of appetite, etc.). In some cases this reaction manifests itself as a slight feeling of intoxication during the bath and some minutes afterward, while other patients feel especially refreshed and invigorated. This reaction, which strikingly resembles the reaction produced by many natural bathing and drinking waters, is a presage of success.

Though this radium-water cure is yet of too recent date to allow definite conclusions to be drawn, it doubtless constitutes a valuable addition to the present methods of modern medicine.

ALEXANDER GRAHAM BELL.

(*Continued from page 462.*)

the free end of one of his steel reeds to the center of a membrane capable, like the ear drum, of taking up any kind of vibration. The fixed end of the reed was not to be clamped, but was to be hinged loosely to the polarizing magnet, so that it would no longer have any definite rate of vibration, but would follow all the vibrations of the membrane. A similar instrument was to be used as a receiver. But the apparatus was not constructed at that time because Bell doubted whether the currents generated by the action of the voice alone would suffice for practical telephony. Furthermore, he was induced by his associates to devote his attention to multiple telegraphy.

One day, in tuning and testing the clamped reeds of his transmitters and receivers he found that the receiving reed vibrated and sounded when the transmitting reed of the same pitch was plucked, although the battery was not in circuit. This discovery convinced him that the membrane speaking telephone devised a year earlier could be made to work.

The long and patient researches that followed cannot be here detailed. Membranes with attached patches of iron and steel of various dimensions were tried, and the apparatus was varied in many other ways. Then it was discovered that a thin sheet of iron could be used as the membrane. Thus were developed, successively, the apparatus patented in 1876, the telephones that created so profound a sensation at the Centennial Exhibition in the same year, the instruments patented in 1877, and the familiar hand telephone which, with some modifications, is still universally employed as a telephone receiver.

From the beginning Bell had aimed at the production of an undulatory current, capable of representing all the component harmonic vibrations of vocal sounds. This fact sharply distinguishes his invention from the old Reis telephone which, employing an intermittent current, produced by alternately making and breaking the circuit, reproduced only the pitch of a sound, but not its quality or *timbre*, and was consequently unable to transmit vocal sounds and articulate speech.

It is safe to say that no patents for any invention have been subjected to such long and bitter litigation as the Bell telephone patents. During one of the many suits which involved the validity of the patent, Mr. Bell was on the stand for fifty-two days, during which time he recited the history of his invention with a clearness and conciseness that still characterize both his writings and his speeches. As we see it to-day, the telephone is practically the same in principle and construction as when it left its inventor's hands, so far as the receiver is concerned. Few inventions have changed so little. To be sure, the appearance of the apparatus has been greatly modified. The multiple switchboard and the common battery system have been introduced, and the very difficult art of telephone engineering has been developed. But for all that, the telephone still remains the same in principle.

Professor Bell makes no claim to business ability. He even states that had it not been for his father-in-law, Mr. Hub-

(*Concluded on page 471.*)

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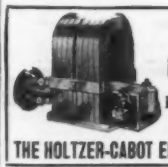

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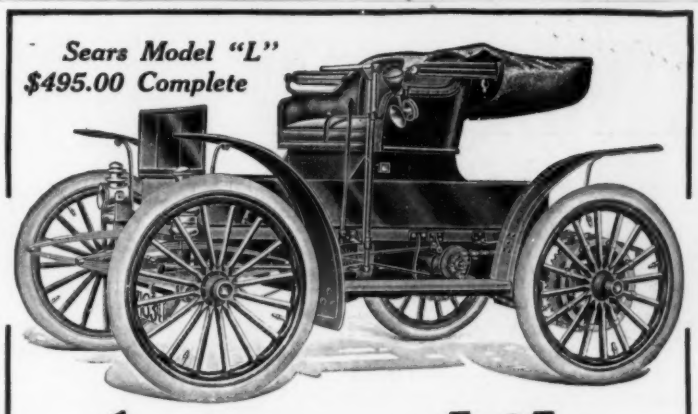
(Concluded from page 470.)

bard, first president of the first telephone company, it is doubtful if the telephone industry would have been so rapidly developed. Fortunately, the original owners and promoters of the telephone were, above all, business men, actuated by the sole idea of developing the business along broad lines. Whatever reward they expected or received was the legitimate reward following the legitimate development of a substantial and beneficial business. To develop that business it was first necessary to develop an art. There was nothing like that art in existence at the time. Indeed, the whole art of the practical application of electricity was new.

The telephone is not the only art with which Professor Bell's name is linked. In wireless signaling, too, he made some early experiments which, had they been extended, might eventually have led him into the field of wireless telegraphy and telephony. During experiments which he made on the Potomac River in 1878 and 1879, he succeeded in signaling for over a mile. He informed the writer of this article that an account of his work on the Potomac River which he gave to Preece in England, may possibly have influenced Preece in his own work. His attention was first called to the subject in 1877, when he was experimenting on ground connections. He used pokers as terminals. When he thrust a poker into the ground and put the telephone to his ear he heard a clock ticking. It was the Cambridge Observatory clock, which he easily recognized because it missed a tick now and then as it regulated the time in Boston. Cambridge was nowhere near Mr. Hubbard's country seat, where the experiments were conducted.

Aerial locomotion is another art with which Professor Bell has become identified. His interest in the subject was aroused when, in 1880, he began to make kite-flying experiments, largely for the sake of his health. He started with a Hargrave box kite and eventually developed the tetrahedral principle, which is now well known among aeronauts. During the course of his experiments he found that he needed the services of civil and mechanical engineers. Accordingly, a little association was started under the name "Aerial Experiment Association," which included among its members the late Lieut. Selfridge, Glenn Curtiss, Baldwin, and McCurdy, all of them now well known. Baldwin and McCurdy acted as engineers; Curtiss was the motor authority. The association was Mrs. Bell's idea, and was founded to carry on Mr. Bell's own work. She sold the only piece of property which was hers in her own right, and which had not been given to her by Mr. Bell, in order to finance the association. Although these engineers were all originally engaged to help Mr. Bell in his tetrahedral experiments, the members of the association ended by helping one another. Selfridge was the first man who profited by the association's assistance. Believing that it was best to follow in the footsteps of others, and then to improve on their work, he started with gliders, and finally built the "Red Wing," which flew successfully. Next came Baldwin's chance. He embodied his ideas in the "White Wing," in which wing tips were introduced, controlling devices which are now the subject of so much controversy. Then came Curtiss's "June Bug," which won the Scientific American Trophy. McCurdy followed with the "Silver Dart." Baldwin and Bell worked at the tetrahedral principle in Nova Scotia, experiments which are not yet concluded. Curtiss remained at Hammondsport, New York, and Selfridge was recalled to Washington by the War Department. The association was so scattered that it was necessary to adopt some means of communication. Hence, the weekly bulletins were started under the title "Bulletin of the Aerial Experiment Association," which had a combined circulation of seven, and which served the purpose of keeping the members in touch with one another.



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HEIGHT OF THE ANTARCTIC CONTINENT.

(Concluded from page 464.)

concludes that, if the continent covers an area of 5,200,000 square miles, as Bruce and Kreummel assume, its mean elevation above sea level is about 6,600 feet, with a probable error of ± 660 feet.

If this estimate is approximately correct, as the results of the recent explorations appear to indicate, the Antarctic continent is by far the highest mass of land on the globe. By the addition of this huge polar cap the mean elevation of the entire land surface of the earth is increased from 2,312 feet to 2,706 feet.

The process by which Meinardus reached these conclusions may be sketched as follows: It was already known that the mean height of the barometer over the northern hemisphere is 0.8 millimeter higher in January than in July, but that the corresponding barometric height for the zone extending from the equator to 50 degrees south latitude is 2.1 millimeters lower in January than in July. Hence, as the entire mass of the atmosphere and, consequently, the average atmospheric pressure over the whole surface of the globe remains constant, the mean barometric height for the zone south of 50 degrees south latitude, which is equal in area to about one-fourth of the southern hemisphere, must be about 3.6 millimeters greater in January than in July.

The observations made by recent explorers, however, led Meinardus to the conclusion that the mean atmospheric pressure over the zone lying between 50 degrees south latitude and the Antarctic circle is not greater, but is 0.73 millimeter less in January than in July. This result increases the January deficit of pressure and restricts the area in which it can be made up to the Antarctic zone, in which, consequently, the mean atmospheric pressure must be 11 millimeters higher in January than in July. Within the Antarctic circle the only observations available for this discussion are those of the ships "Discovery," "Belgica," and "Southern Cross," which together comprise the records of four entire years. In three of these years the atmospheric pressure was lower in January than in July. Thus the area in which compensation for the deficit can be sought is still further restricted, apparently to the Antarctic continent.

Meinardus finds the explanation of this puzzling state of affairs in the great height of the Antarctic continent. The atmospheric pressure diminishes as the elevation of the point of observation increases, and the difference is greater at low than at high temperatures. Hence, in a region where the atmospheric pressure is constant throughout the year at the sea level, it is appreciably higher in summer than in winter, at an elevation of several thousand feet. For a given elevation, this difference increases with the difference between the summer and the winter temperature. Meinardus and Hann have computed that the mean atmospheric temperature of the Antarctic continent is +26.6 deg. F. in January (Antarctic midsummer) and —14.8 deg. F. in July (Antarctic midwinter). In these conditions it can be calculated that the mean excess of January over July pressure (11 millimeters) required for the entire Antarctic zone would be furnished by a mean elevation of that zone of about 4,400 feet, on the assumption of a constant atmospheric pressure at the sea level. But the coasts of the Antarctic continent have been explored sufficiently to make it reasonably certain that that continent occupies, very approximately, two-thirds of the entire area of the Antarctic zone. Hence, on the assumption of a constant atmospheric pressure over the remaining third, which is covered by water, Meinardus arrives at the conclusion that the average height of the Antarctic continent is about 6,600 feet.

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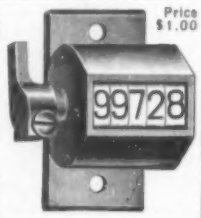

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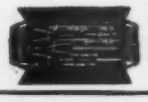

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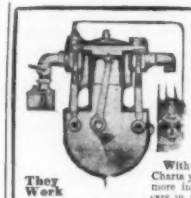

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